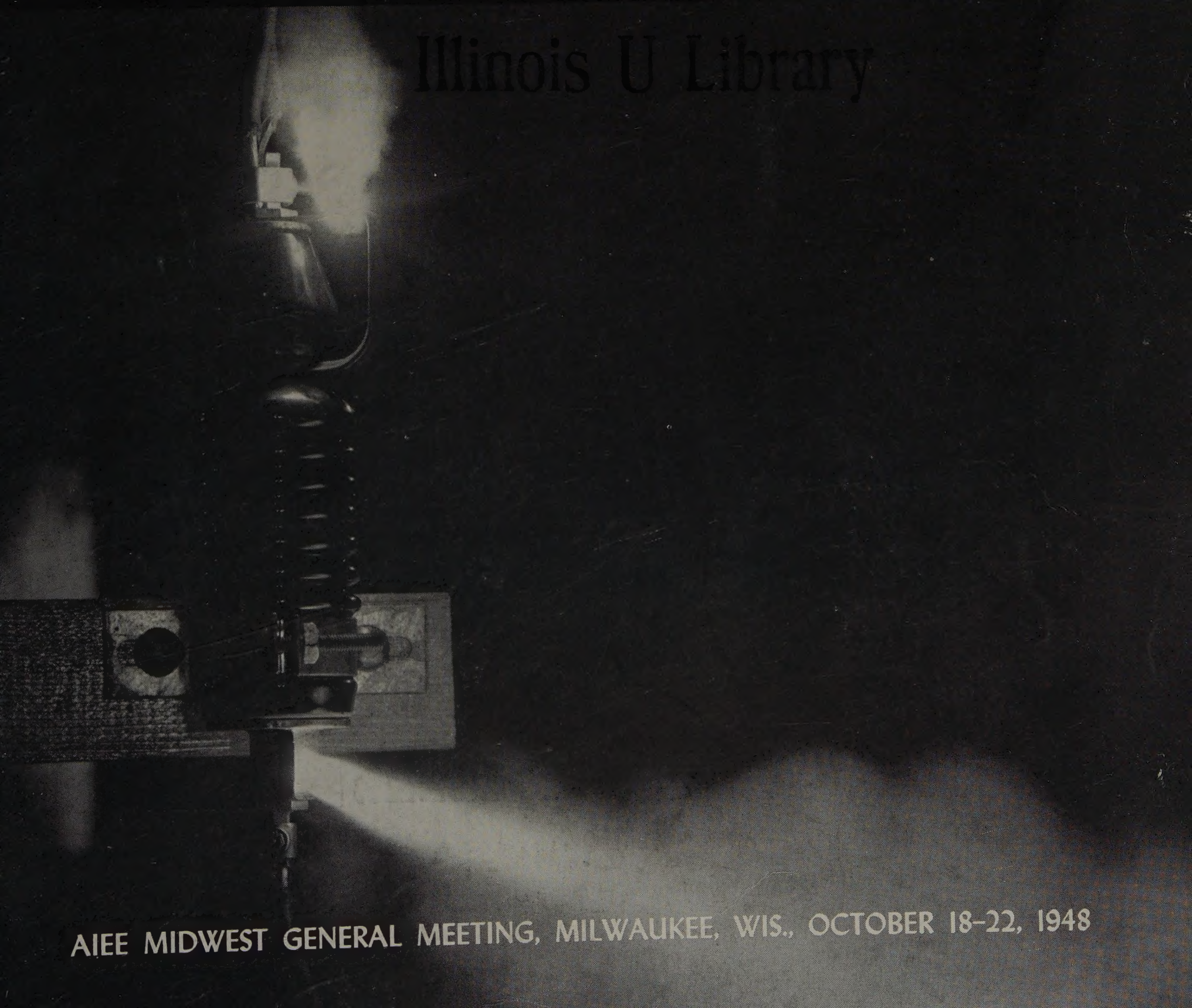
ELECTRICAL ENGINEERING

OCTOBER 1948



AIEE MIDWEST GENERAL MEETING, MILWAUKEE, WIS., OCTOBER 18–22, 1948

ELECTRICAL ENGINEERING

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OCTOBER 1948

The Cover: Testing expulsion-type distribution lightning arresters in the research division of the Line Material Company, scheduled for inspection during the Midwest general meeting in Milwaukee, Wis.

Statements and opinions given in articles and papers appearing in *ELECTRICAL ENGINEERING* are the expressions of contributors, for which the Institute assumes no responsibility. ¶ Correspondence is invited on all controversial matters.

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HIGHLIGHTS........

Publications Staff Changes. G. Ross Henninger has resigned as editor of *ELECTRICAL ENGINEERING* to become editor and director of publications for the Illuminating Engineering Society. He will be succeeded by Charles S. Rich, who has been secretary of the AIEE technical program committee. W. R. MacDonald, associate editor of *ELECTRICAL ENGINEERING*, also has resigned, because of ill health (*page 1000*).

New Section Chairmen. Approximately half of the new AIEE Section chairmen for 1948–49 are being introduced to the membership in this issue, with photographs of the others scheduled for November (*pages 1004–5*).

AIEE Meetings. The fall season of AIEE activities is in full swing with two District meetings and one general meeting scheduled for the remainder of the calendar year. In the order of occurrence they are the Middle Eastern District meeting which is to be held in Washington, D. C., October 5–7, 1948, the program for which was published last month (*EE, Sept '48, pp 910–11*); the Midwest general meeting, scheduled for Milwaukee, Wis., October 18–22, 1948, the program for which appears in this issue (*pages 998–9*); and the Southern District meeting which will be held in Birmingham, Ala., November 3–5, 1948, the program for which also appears in this issue (*page 1001*).

AIEE PROCEEDINGS. The third order form for 1948 AIEE *PROCEEDINGS* sections appears in this issue (*pages 43A and 44A*). This order form lists papers that were presented at the Pacific general meeting held in Spokane, Wash., August 24–27, 1948; and those being presented at the Middle Eastern District meeting, Washington, D. C., October 5–7, 1948. Members interested in obtaining AIEE *PROCEEDINGS* sections already published are referred to the AIEE *PROCEEDINGS* box for necessary information (*page 997*).

"Our Institute Membership." A number of interesting statistics on AIEE membership are presented in this month's message from AIEE President Lee (*page 996*).

Section and Branch Officers. The annual listing of Institute Section and Branch officers for the year 1948–49 is presented (*pages 1011–13*).

Board of Directors Meets. A Niagara Falls Section was authorized, among other actions at the August 5 meeting of the board of directors (*pages 1006–07*).

Pacific Meeting. A report on the various activities that took place during the Pacific general meeting which was held in Spokane, Wash., August 24–27, 1948, appears in this issue (*pages 1007–10*).

Digests. A digest of one technical paper presented at the AIEE summer general meeting appears in this issue (*page 940*). The remaining digests are for Pacific general meeting papers (*pages 941, 945, 946, 954, 955, 961, 967, 968, 972, 973, 979, 980, 986, 987, 994, 995*).

Reading and the Engineer. One way that the engineer can obtain a further education in the humanities is by reading a better type of literature. A list of 26 great books is presented as a starter (*page 960*).

Engineering Training. Engineering training can provide a liberal education once we recognize the fact that its fundamental purpose is not to fit students to a mold, but, as all education, to develop the man mentally, morally, and physically. True, education makes for inequalities, but "inequality, not mediocrity, individual superiority, not standardization, is a measure of the progress of the world" (*pages 935–9*).

Mathematics for Engineers. Following up the enthusiastic response to a presentation at the 1948 AIEE winter general meeting, there begins in this issue the first in a series of three articles on applied mathematics. In this part the reasons why functions are fitted to data and the possible sources of error are discussed (*pages 988–93*).

Polarity of D-C Control. Results are reported of a survey of manufacturers conducted to ascertain their experiences with standardization of polarity of d-c control (*page 985*).

Snow Static. Airplanes flying through snow can acquire an electrostatic charge which can produce corona and consequent interference with radio reception. A method for overcoming the interference-producing discharges is proposed by an author who was associated with the problem for many years (*pages 947–53*).

Practical Economics. Industrial plants which use both steam and electric power may find it economical to use some of the steam power to meet electric power requirements. One plant found it possible to realize a return of 25 per cent on the cost of the necessary additional equipment (*pages 956–9*).

Student Prize Paper. The prize winning AIEE Student Branch paper for the academic year 1946–47 considered the characteristic of a single-tube time-delay control circuit (*pages 974–7*).

Nuclear Reactors. A discussion of the considerations and problems involved in the use of nuclear reactors for power generation completes *ELECTRICAL ENGINEERING*'s recent series of articles on the general subject of nucleonics. The entire series will be available in pamphlet form (*pages 962–6*).

Motor Standards. Three organizations have prepared standards covering various aspects of motor application; knowledge of these standards enables motor purchasers to understand what they are buying (*pages 969–71*).

High-Frequency Heating. Promotion of high-frequency heating equipment by utility companies permits customers to bring forward their problems without a feeling of obligation to equipment manufacturers (*pages 981–4*).

High-Speed Reclosing. Experience with high-speed reclosing of circuit breakers following transmission line faults has given a record of 80 per cent successful reclosure without other interconnection, and 77.1 per cent with other connecting lines in service, indicating that the unsuccessful reclosures were not due to the loss of synchronism (*pages 942–4*).

News Index

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Engineering Training—An Instrument of Progress

A. G. CONRAD
MEMBER AIEE

The objectives of an engineering education can be realized fully only when it is recognized that these objectives, in common with those of all education, are not merely the development of technical abilities, but the development of the man mentally, morally, and physically. Through his scientific and technological contributions, the engineer ably fulfills his duty as an engineer, but he must be trained to assume a further responsibility—his responsibility to the society of which he is a member.

THE OLD PROVERB that necessity is the mother of invention is subject to question. In most instances, necessity is the mother of substitutes. It also has been stated that wars bring about inventions. This may be true in some cases, but, more frequently, the innovations of war are substitutes, rather than inventions. During the past decade, we have seen the substitution of plastics for metal, government control for private enterprise, automatic machines for human labor, rayon for silk, hatred for love, destruction for construction, starvation for nutrition, and specialized training for education.

World War II can be considered a substitute. It was a substitute for an adequate method of settling an international dispute, in somewhat the same manner that amputation is used in the medical profession where there is no adequate cure for the afflicted member. Probably one of the most outstanding substitutes resulting from the war has been that of change for complacency. It has been difficult for people to accept change. They like one brand of toothpaste and only one. They attend one church and only one. They are partial to one make of automobile, and they are suspicious of a change in government administration.

Substitutions and changes usually are brought about by necessity. Throughout the world today, people are accepting many substitutions and changes, with the realization that they are necessary for the preservation of their way of life and for their very existence. They accept heavy taxation because they feel it is necessary for the preservation of their national security. They accept labor unions and strikes, not because they like them, but because they seem necessary to the maintenance of their standard of living. Changes are taking place in all phases of life, at an ever-increasing rate, and our concept of what is normal is being revised continually as a result of such changes.

The last war has jolted us into realizing that the resources of the world are not inexhaustible. Forests are disappearing. Oklahoma is running out of zinc and lead. Oil supplies may not last more than 25 years. The productivity of a large portion of the world has been destroyed, and in countries unscathed by the conflict, production is being retarded dangerously because of misunderstandings between labor and management. Productive capacity is worthless unless it can be put to good use. Yet productive capacity is a necessity in our modern civilization. Man no longer can support himself without the aid of the natural resources that have been harnessed for him by the scientist and the engineer.

The mechanical output of man is not large. A brawny athlete, working at full capacity, can do approximately the same amount of work in a day as a one-tenth horsepower motor working during an equal interval. This energy evaluated on the basis of the energy rate of one of our local public utilities would be worth approximately four cents per day. Of course this is not all of the mechanical output of a human being. At rest the average person radiates heat at about the same rate as a 70-watt lamp. This radiated energy is worth about seven cents per day. The total energy output of the average individual is therefore worth approximately 11 cents per day. The food consumed by the average person is worth approximately $1.50 per day, but in return the best that can be expected is 11 cents' worth of energy. This efficiency is nothing for the human race to brag about.

How then can a civilization exist when our consumption is so much greater than what we ourselves are able to produce? The answer is simple. We are parasites. We are living on what we can get out of the storehouse of civilization and our most generous benefactor is Mother Nature. She has placed coal in our hills, oil in our sands, and water in our streams. These, our natural resources, are the things that permit us to enjoy a standard of living that our ancestors never dreamed of. The importance of these resources is not limited to their effects on our standards of living. National resources are a far greater factor in deciding the supremacy of nations than dynasties or conquests. It is the lack of these resources that has made some dictators aggressive for additional territories and at the same time, in other parts of the world, the scarcity of these resources has limited aggression more than peace treaties. The rate at which these resources are being used is appalling. In some parts of the world, they practically are exhausted. In later life we probably will regret having used them so lavishly at this time. In spite of this fact, we are doing nothing to conserve them. Thrift is inconvenient.

Essentially full text of paper **48-145**, "Engineering Training—An Instrument of Progress," recommended by the AIEE education committee and approved by the AIEE technical program committee for presentation at the AIEE summer general meeting, Mexico, Federal District, Mexico, June 21–25, 1948. Not scheduled for publication in AIEE *TRANSACTIONS*.

A. G. Conrad is chairman, department of electrical engineering, Yale University, New Haven, Conn.

THE ROLE OF THE ENGINEER

The United States is particularly fortunate in having one-half of the world's coal supply, or approximately 3,830,000,000,000 tons. If this coal is converted to electric energy and sold for four cents per kilowatt-hour, it would bring a return of approximately $300,000,000,000,000. This is about 30,000 times the value of the entire gold supply of the world. However, it has not always been of such value. The value of a resource depends on the use to which it can be put in supplying man's needs. Our coal had little value 70 years ago. People did not realize its value as a fuel. But through science and engineering this worthless black deposit has been made to have a value of $300,000,000,000,000. This represents the creation of wealth—this is engineering. The engineer creates wealth. The economist attempts to control its distribution—he does not create it. These natural resources have provided wealth. The standard of living in the world today is directly dependent upon the intelligent and continued use of these resources. It has been said that electricity in modern life is second in importance only to food and shelter. If we were to open the switches in our power plants, our modern machines would be worthless. Our refrigerators and heating systems would cease to function and elevators would stop between floors in darkened shafts. Fire and police systems would be inoperative and crime would be rampant within 24 hours. Telephones and radio would be replaced by the next highest-speed communication system known in the past as wig-wagging, and the baby being born in the maternity ward would arrive in the world under approximately the same intensity of illumination as did his great-great-grandfather. If we were to do away with electricity, we would be back where we were 150 years ago.

The engineer has provided a power supply system which has made cheap energy available to nearly everyone. He has provided transportation systems of many forms. He has provided communication systems that have surpassed human concepts of 100 years ago. However, the main purpose of all of this engineering is not to provide a comfortable existence. Engineering has a deeper meaning than the mere utilization of resources. Engineering is an instrument of "social progress." History has shown that the great advances in literature, art, and philosophy have been made by a comparatively few people who have been provided, through the economic and social systems in which they lived, with the opportunity to devote their time and energies to such advancements. In the early days this meant that many slaves were required for every scholar or member of the "intelligentsia" who was not devoting his time to the process of earning his own living. Today, engineering achievements are providing an equivalent of 50 slaves for every man, woman, and child in the United States. In so doing, engineering has given nearly all of our people the opportunities for an intellectual development that heretofore was restricted to a very few. Thus we see that engineering is not only necessary if our American way of life is to be continued, but it is also a key to technical, social, and economic progress.

This progress cannot be attributed entirely to the presence of natural resources. Such resources have been present for years. It has taken millions of years to bring them to human usefulness. The great advances in civilization have been brought about by comparatively few individuals who have not conformed to the pattern of the average man. They have been men of superior intellect—men with originality and inventive genius—men of courage. They have made possible the utilization of natural resources by providing what might well be called intellectual resources.

The need for such men has not diminished. Pioneering in science and engineering is necessary to the continuation of progress. The fields of research have not been harvested. Knowledge stands before us like the Rock of Gibraltar, and is just about as hard to penetrate. Every few years some rugged individual with plenty of originality, foresight, and initiative appears on this rock with an ample supply of intellectual dynamite and proceeds to blast away some huge chunks. Then a lot of lesser individuals come along with their special tools and pick away at the pieces. Men who have blasted away some sizeable chunks are well known. When Edison invented the incandescent lamp, he started the electric power industry, which now has an annual revenue of nearly four billion dollars. Bell with his invention of the telephone started an industry that has revolutionized the country and at the present time employs more than half a million people—that is engineering. When Westinghouse developed his a-c system of transmission he made possible the use of energy in one part of the country from a source in another part—that is engineering. When Kettering invented the electric starter for the automobile he placed under the hoods of American cars more horsepower in the form of starting motors than is installed in all the powerhouses in the country, and at the same time prevented the breaking of 60,000 human arms annually—that is engineering.

EDUCATING AN ENGINEER

The changes brought about by engineering are universally recognized and approved. These changes have altered our entire concept of living and they have reflected back to the universities causing changes in our concepts of education. Engineering training has grown by leaps and bounds in its attempt to keep up with the ever-increasing demand for engineers. The changes of engineering education have been so rapid that entirely too frequently the purpose of the training is obscured in a mass of erroneous concepts as to its fundamental objective.

What is the fundamental purpose of engineering education? There are many answers to this question, depending largely on who provides them. I find many industrialists who feel that it is the duty of the university to set up engineering courses and curricula for the purpose of providing specialized training that will prepare the student to fit into some industrial jobs open in their particular companies. I find many students who feel that the purpose is to provide training which will permit them to get a job with a good salary. I find an army general who feels that the engineering curricula should be set up to train men in the technical subjects that are important to the defense of a

nation. All of these may be objectives, but they are certainly not the main purposes of engineering training. They are secondary at best—their vector sum is approximately zero.

There is not a unanimity of opinion among engineering educators as to what constitutes an adequate engineering curricula. The American Society for Engineering Education has had committees functioning on this for years. Much discussion has taken place on the proper ratio of the humanistic studies to the technical studies provided in the engineering program. Attempts have been made to determine a consensus of opinion as to the best proportion. As a result of these surveys, there has been much standardization of engineering curricula in many universities but there is little evidence that such standardization is beneficial. Who can say that the great advances in education are not brought about as the result of dissimilarities of curricula rather than their uniformity? Standardization retards change and change is essential to progress. The engineering curricula should not be built on information obtained from such "Gallup Poll" data. There is nothing sacred about a curriculum. It consists merely of a listing of courses and subjects for administrative purposes. Curricula for the very best and the very poorest schools may appear the same on paper, just as the menu at the "Waldorf" may be similar to that prepared by "Joe's Beanery." There is vast difference in the intellectual nourishment obtained from curricula presented by an incompetent faculty in comparison to that obtainable from a staff comprised of competent educators and scholars working in the intellectual atmosphere of a true university.

No one questions the value of good teaching or the importance of education. There are many, however, who doubt that an intellectual climate can be created in an engineering laboratory. We who are connected with the older educational institutions on the Atlantic seaboard quite frequently encounter educators who admit the triumphs of engineering but who are not inclined to extend similar appreciation to engineering education. They feel that engineering training, as given in our engineering schools, is not a valid education. Their views in this matter are shared by people in many walks of life. They feel the engineering education is materialistic in nature. It does not provide the engineering student with an understanding of man himself. Engineering has done wonders to make life easier but it has not made people happier. The devastating implements of warfare are products of engineering activity. The engineer should think more about the efficiency of government and spend less time on the efficiency of his machines. The ills of the world are attributed to an overemphasis on science and engineering and a lack of appreciation of the humanities. The cure for these deficiencies on the part of the engineering student is prescribed in the form of the so-called humanistic studies to be inserted into the engineering curricula.

A large portion of this criticism is absurd and is not accepted by the engineer. He is well satisfied to stay in his own field where his rigid and logical approach to problems have proved adequate. He is not interested in projects that do not lend themselves to engineering approach. He likes to apply his mathematics to the problems at hand and to crank out the exact solutions. He is not interested in the nebulous problems that arise in society and in politics that do not yield to standard engineering techniques. Generalities and intuition are not exact; they are not dependable in engineering. They are used by the man in humanities as substitutes for the basic thinking and the exactitudes that characterize the engineering approach. The engineer is well aware of the ills of the world, but he does not accept the responsibility for them. After all, if social education had kept pace with engineering education, some of the acute problems of the world today would not exist. He knows that wars were fought long before the earliest concept of engineering education. He knows that a war is started when someone wishes to fight, and when someone wishes to fight, he must be accommodated. He has never seen a "right wing" or a "left wing" in the engineering profession where controversy always yields to logic. He dislikes fascism and communism and other forms of undemocratic government. He knows that none of these "isms" ever were incubated in an engineering office or on a drafting board.

EVOLUTION OF CURRICULA

The divergences of opinion listed have prevailed for several decades. Fortunately, these differences as to our concepts of a valid education are not as great today as they have been in the past. There has been some respectable thinking by educators as to the relative importance of technical education as compared with that of the humanities. Many of the advocates of the restricted liberal arts education are beginning to see the importance of science and engineering. Introduction of the sciences into the curricula has been a change common in many of the liberal arts colleges within the last three years. Likewise, the engineering curricula have been undergoing some revision. The greatest changes are occurring in the programs offered in electrical engineering. These changes have done much to bridge the gap between the objectives of the liberal arts man and those of the engineer.

Specialization gradually has been moved out of the undergraduate program for electrical engineers, and in its place we find greater emphasis on the fundamentals of the basic sciences. Design courses and material on industrial processes have been minimized and greater emphasis has been placed on teaching of engineering synthesis, along with engineering analysis. The importance of training for engineering research is taking precedence over training for engineering development. Courses in the humanities are replacing those formerly offered in industrial organization and management, plane surveying, and other courses which are related only remotely to electrical engineering.

These changes are taking place gradually, and they are approved universally by faculty and students. Research is of paramount importance, especially to the graduate student of today. At present, the students are serious-minded and they have well-formed objectives. They are much more interested in the creation of new things than in the manufacture of old devices. They look to the fields

of research rather than to production as an outlet for their intellectual curiosity and their inventive genius. This is good and it will mean much to the industries that recognize this attitude and give it support and encouragement.

Engineering analysis, which was considered to be all important in electrical engineering work, is being challenged by engineering synthesis. For years, students have been given courses in vector analysis, circuit analysis, stress analysis, engineering analysis, but entirely too little thought has been given to engineering synthesis. Analysis teaches a student to tear down a problem into its components so that it may be more thoroughly understood. Synthesis teaches the student to put these components together in their most useful form—this is engineering.

Originality and inventive genius should be encouraged in all engineering courses. A student should be taught to create and to devise. It is more important that he devise new methods of solving problems than it is to apply old methods in a mechanistic fashion. Such attitudes are necessary if progress is to be made in engineering. Originality and inventiveness are as much a part of a human being as his ability to swim. A man never learns to swim unless he gets in the water. He will not develop creative talents unless he is exposed to an intellectual environment which will demand continuous use of these natural talents. Some courses should be presented for the specific purpose of developing these creative attitudes. The subject matter of the course is of far less importance than the mental disciplines that it leaves with the student. The course is merely the agent by which these disciplines are developed.

ENGINEERING AND SOCIETY

The objectives of technical education have been well established and the technical achievements of the engineering graduate of today surpass those of his predecessors. However, the engineer is not completely satisfied with the manner in which the fruits of endeavor are being used. He has become increasingly aware that society is not keeping pace with the continuous advancements in technology. He is well aware that the great destruction resulting from the last war has been brought about through an abuse of engineering by people who have not the faintest concept of its fundamental purposes. He is well aware that more logic has gone into the design of a microphone than has ever passed through it during normal use. He has seen the principles of engineering applied to machines that are capable of destroying mankind—yet the human race cannot develop a cure for a common head cold. He sees his well-designed machines that are capable of producing useful goods standing idle while labor and management argue over terms of employment. He has learned to solve the problems of science and engineering with great accuracies, but the human equation remains unsolved. The world today is in a greater need of a mental reconstruction than a physical reconstruction.

Educators in America have a lesson to learn from the German University, where technical excellence was developed to a degree that the intellectual freedoms which were thought to be the basis of their system of education gave way to an enslavement of the mind dictated by political prejudices and class hatreds. The responsibility for world citizenship cannot be avoided by the engineer. He must be trained to meet these responsibilities. It should be part of the education of an engineer to understand man himself. It is just as important that the engineer understand what goes on in the human heart as it is for him to understand the behavior of some man-made electric machine. Yet the predictions of man's behavior cannot be made from engineering formulas. Something more than technical training is needed for the engineering student if his education is to be kept from being "lopsided" and narrow. His education should extend beyond what can be seen through the laboratory doors. It should include the humanities.

Much discussion has taken place in recent years as to the "humanistic stems" of the engineering curricula. These "stems" refer to a series of cultural courses extending through the 4-year program. The objectives of this administrative procedure are excellent, but unfortunately these courses have not, in many cases, been successful. They have served as excellent ornamentalities, but the mere listing of courses in a curriculum is not enough. Many of the so-called humanistic courses are as dehydrated and sterile as any of those ever found in engineering. Humanities can be taught only by those who understand them and such teachers are not to be found in only one university department or in only one school of a true university. There are as many true educators found in science and engineering as in the liberal arts departments. One of the best writers ever known to the author is a professor of applied physiology; another is a professor of civil engineering. Another professor who teaches physics also can teach an excellent course in philosophy. It is this type of teacher that is needed in the engineering colleges today. If the student can be exposed to a faculty that is educated and not just trained, we need not worry about the so-called "stems" or the validity of engineering education. This is in no way an implication that thorough training in basic science and engineering is less important today than it has been in the past. It is more important than ever before. However, the objectives of engineering education cannot be realized fully unless such training can be presented by a faculty that can reveal to the student that:

1. The objectives of a scientific, liberal arts, or engineering education are common. The purpose of an education is to develop the man—mentally, morally, and physically.
2. The laws that govern human beings are as important to the welfare of society as the laws of science and engineering.
3. An understanding of man is as important, or more important, than an understanding of man-made machines. Man should not be a slave to machines—the machines should be the slaves of men.
4. Advancements in civilization are dependent upon the intelligent use of man's efforts as well as the use of natural resources.
5. It is not the main purpose of an engineering education to provide the student with sufficient technical information to earn a living. Its main purpose is to develop the student.
6. The engineer has a responsibility to the society of which he is a member. He has the responsibility of being a world citizen.

Such concepts usually are not found in the common engineering courses nor can one expect to find them in a course on Chaucer. They do not come from a faculty

composed of artisans, technicians, and pedagogues who are not scholars. The source of such attitudes will be found in those members of the faculty whose education is broad, rather than restricted, and whose interests and knowledge extend beyond the laboratory and beyond the novel, whose interests are in the development of all phases of the intellectual ability of the student. A competent faculty is a university's greatest asset.

The words "engineering education" are misleading. I never have liked this restricted definition of a man's achievements. Why is not an engineer an educated man just as much as the physicist, the chemist, the historian, or the philosopher? We never label these men with "chemical education," "historical education," or other restrictive adjectives. They are accepted as educated men. The engineer did not receive an engineering birth. He did not lead an engineering life. He is not given an engineering burial. Why, then, must we refer to his training as an "engineering" education? Why can he not be considered an educated man? Engineering training can provide a liberal education once we establish our concepts as to its fundamental purpose. Certainly such concepts cannot be based on some particular curriculum to which all students must be subjected. The student never should be made to fit a mold. He should have opportunity to pursue studies outside of his major and he should be encouraged to do so. Standardization of courses and curricula may result in more uniformity in our graduates, but it is contrary to the principles of education. True education makes for inequality—the inequality of individuality, the inequality of success, the glorious inequality of talent and genius. For inequality, not mediocrity, individual superiority, not standardization, is a measure of the progress of the world.

Electrets—Nonmetallic Magnets

Tests, made during the recent surge of nuclear physics research, have disproved the belief that permanent magnetism is a phenomenon exclusively related to metals, and have shown that magnetism is a more or less inherent feature of every substance, with each atom acting as a magnet within the molecule. With new concepts of electricity and magnetism, it is known that some of the most highly retentive materials are nonferrous. With magnetic theory interpreted in terms of electron flow, it is possible that assemblies of dielectrics, given permanent electrostatic charges, might react like magnets on other material.

A progress report by Thomas A. Dickinson on applications of this theory to plastics was published in the August 1948 issue of *Electrical Manufacturing*. He writes about plastic "electrets," a term used to describe those dielectric bodies which can retain an electric moment after the externally applied electric field has been reduced to zero.

The idea for such substances was suggested by Michael Faraday as early as 1839, but the first electrets, using wax, were made by Mototaro Eguchi, Japanese physicist, in the early 1920's. His theory stated: "When an electric field is applied to a melted substance, clusters of molecules (which supposedly contain electric doublets) orient themselves with their axes in the direction of the electric field so that, when the substance solidifies, the molecules will retain their orientation, causing the substance to retain a permanent electric polarization."

An electret has been described more exactly as a permanently electrically polarized material that exhibits an electric field near its surface which remains undiminished for years. It may be fabricated by the comparatively simple method of utilizing a strong electric field to vary the orientation of atoms in certain types of dielectric materials. In general, materials from which electrets can be fabricated must have a complex molecular structure with enough double bonds to permit reorientation of atoms without disintegration in the electric field, and must have thermohardening or thermoplastic properties which will permit the material to solidify from a liquid or near-fluid state in the electric field. The material should be more or less fluid when first exposed, because its atoms then will not be rigidly united and so offer resistance to external forces.

Manufacturing processes have been developed for electrets, using plastics and ceramics. Though ceramics are useful whenever high-temperature resistance is specified, plastics are preferred because they can be fabricated with maximum economy, can be made transparent or opaque in varied colors, can be compounded with nonplastics for desirable properties, and can be machined or shaped without danger of damage after electrification.

Charging currents to electrify resin compounds are difficult to compute because of the large number of variables. However, an electromotive force of 4,000 to 12,000 volts meets most production requirements. High amperage is not essential because the exothermal reactivity necessitates minimum heating effects within the electric field. Electrification and molding of an electret are accomplished simultaneously with 2-piece metal molds separately charged by the terminals of a d-c power source. Standardized specimens have an average charge equivalent to one coulomb per second in 5-minute tests, and show no appreciable diminution of electrification after more than a year.

Because electrization does not deteriorate readily, it is believed that plastic electrets will make inexpensive, highly efficient microphones and loud-speakers. Made transparent, they can find use in the manufacture of optical and photographic instruments, and they already are being used as a source of energy in midget batteries.

The Role of Engineers in Mexico's Development

LOUIS ALFONSO GUERRERO

MEXICO'S INDUSTRIAL DEVELOPMENT should be carried out on bases that would take advantage of the peculiarities of the people and of the country. Emphasis should be placed in the production of agricultural products of durable nature or of immediate industrial use, in the production of refined minerals and of chemical substances in bulk. The type of manual workers and of technicians available are adapted to this type of manufacture much better than to manufacture in large scale of articles of intricate design that require rigid inspection and uniformity.

Mexico's oil industry may be depended on to furnish the oil needed in the future growth of industry, even if great improvements can be made in its organization and performance, after the trial period through which it has passed in the last ten years. The following brief discussion contains some of the ideas, suggestions, and feelings of many men in the oil industry of Mexico. An effort has been made to present them in a condensed form in a logical aspect and orderly sequence, with the object of presenting an over-all view of the general aspect of working conditions in the country in relation to the labor of the engineers. The problem has been presented as free of prejudice as possible so that a better appreciation may be had of the task involved in the planning and carrying out of the industrial development of Mexico.

If the road of industrial development is once chosen, the very same forces released by the process will be effective in carrying it out still further. Some fundamental concepts and manners of living of the Mexican people will have to be changed, for better or for worse, and a special effort should be made to preserve the better gifts of its personality.

The production chosen to be fabricated in large scale should be that which is easy to make to rigid and simple specifications, such as agricultural products of lasting qualities, refined minerals, and chemicals in bulk; this in order to prevent that the individualistic nature of the people and its inherent disregard of rules of materialistic origin should prevent the success of marketing and selling products difficult to meet standards exact, but difficult to verify.

Planning should conform to a pattern of dispersed, unrelated, independent, and self-sufficient units of cell development growth, in which each unit is independent on the completion of the preceding one. To achieve success a strict adherence to a time schedule should be enforced and the men in charge should be given sufficient but not excessive authority.

A number of serious employment problems face technical men. These include such questions as:

(*a*). The school training faces the practical training in very trying circumstances, specially in the case of young graduates facing experienced men of no schooling.

(*b*). It has been found that in Mexico few specialists have success because there are few employers in need of their services, and they have to turn out to become general practitioners. In time, their varied experiences turns them into men of general knowledge, with common sense, but without acquaintance with the refinements of an art or science in particular.

(*c*). The admission, salaries, and work assignments of the large number of young graduates, in sufficient number to withstand the casualties, has to be given serious thought.

(*d*). The small number of college-trained men should not be employed in positions where they have to attend to mere routine of purely administrative nature, just because they command a higher salary or a more prominent position. They should be paid better for their work as chief engineers even if slightly less than superintendents and contractors.

Industrial development may be carried out at a rapid rate because it has only to graft procedures already evolved and in operation in other countries. Means to furnish access to technical knowledge to those deprived of plentiful means should be made available by suitable libraries and current books and magazines.

The duties imposed on Petroleos Mexicanos are of vital importance to the welfare of the country. Its performance should not be judged to be ephemeral and haphazard, depending on the good or bad luck of a decade. Its activities and reserves should be of such nature, that they could take in their stride these short periods of adverse luck. To the man in the street it is immaterial whether new production is found and what volume this production does reach. He is interested in his own immediate needs and their satisfaction; his judgment of achievement will be biased by this understanding. Nevertheless the concensus of favorable public opinion is a valuable asset to the management of any enterprise, public or privately owned. It is a real help in emergencies and smooths and speeds the daily dealings.

It has been suggested that very much attention should be paid to the general public opinion in all matters connected with the everyday services to the public. But that in matters of large projects and intricate problems, the judgment of the privileged few and of responsible public opinion should be the only deciding factors.

And finally the whole discussion has had as a main purpose to stress the fact that it is extremely important to choose the best men in order to answer the famous questions: what, why, when, how, and most important of all, who, will do it.

Digest of paper **48-148,** "A Few Points on the Role of Engineers and of Petroleos Mexicanos in the Industrial Development of Mexico," recommended by the AIEE chemical, electrochemical, and electrothermal committee and approved by the AIEE technical program committee for presentation at the AIEE summer general meeting, Mexico, Federal District, Mexico, June 21–25, 1948. Not scheduled for publication in AIEE *TRANSACTIONS*.

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Radio for Telephone Service in America

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IN THE 30 YEARS since radio first took a regular place in the United States' telephone plant, its use has spread into many parts of the telephone network, making possible world wide telephony and other extensions of service.

OVERSEAS SERVICE

Radio made its entry into the telephone field by providing the means for interconnecting the continents. At first this was done by a high-powered long-wave circuit from New York, N. Y., to London, England, operating at 5,000 meters or 60 kc. It soon was discovered that the job could be accomplished better and more economically with short waves in the 3,000-to-30,000-kc range which span great distances by being reflected from ionized atmospheric layers. Radio circuits operating in this range now make it possible for any one in the United States to talk to any country in the world having substantial telephone development. Great technical advances have been made, one of the more important being the introduction of single-sideband transmission which not only improves the service but also permits operating two or three telephone channels in the frequency space previously assigned to only one channel operated on a double-sideband basis.

MARITIME AND LAND MOBILE SERVICE

A field where radio has no competitor is in providing telephone service to mobile units. High-seas ships are served by long range radio facilities similar to those used for providing circuits between continents. This service is supplemented by coastal-harbor service given through 15 moderate range stations placed at strategic intervals along the Atlantic, Gulf, and Pacific Coasts and operated on frequencies near 2,000 kc. Similar stations serve vessels on the Great Lakes. For vessels which remain within harbors or on inland waterways, telephone service also is provided through short range stations operated near 40 or 150 megacycles.

A rapidly expanding service is that provided for cars and trucks. This service, which started since the World War II and is now available in 100 cities, employs frequency modulation and operates in the 30–44- or the 152–162-megacycle ranges, the former being used principally where it is desired to provide continuous coverage along a highway by means of a chain of stations, and the latter for serving urban areas. A typical land station in this service consists of a 250-watt transmitter with its antenna on a high building or other elevation, together with several fixed receivers placed at favorable locations within the service area to pick up the relatively weak signals from the lower powered mobile transmitters. A typical mobile station includes a 20-to-40-watt transmitter and a receiver, both placed in the luggage compartment of the automobile, an antenna mounted on the metal roof and a telephone set located below the automobile instrument panel. The aim has been to make the service as much like regular telephone service as possible with the operator dialing the desired car on outgoing calls and answering a lamp signal brought in on a call from a car. The only important difference is that at the car the user must push a button in the handset to talk and release it to listen.

DOMESTIC POINT-TO-POINT RADIOTELEPHONY

The use of radiotelephony for point-to-point communication within the United States until recently has been on a relatively small scale. About 100 portable transmitting and receiving stations have been made available at strategic points within the United States for emergency communication when wire lines are destroyed by storm or flood. Also, radio is used for regular service to islands and other points which are inaccessible to wire lines. For a number of years a 12-channel system operating in the 160- megacycle range has been in service between Cape Henry and Cape Charles across the Chesapeake Bay, this 25-mile radio link being an alternative to wire circuits around the bay, a distance of over 200 miles. Recently, a number of point-to-point circuits employing frequency modulation and operating in the 150-megacycle range have been established to serve isolated areas, such as ranches in Colorado and Death Valley in California.

There is at present great activity in the field of radio relay systems employing microwaves, that is, the frequency range above 1,000 megacycles. A system recently placed in service between New York and Boston, Mass., a distance of more than 200 miles, operates on frequencies near 4,000 megacycles, employs seven intermediate radio relay stations with a clear line-of-sight path between adjacent stations, and provides two communication channels, each more than four million cycles wide, in each direction. Each of these broad channels can be used for television transmission or for the transmission of hundreds of simultaneous telephone conversations. The transmitted power for each of these channels is of the order of one watt and this power is directed toward an adjacent station by means of a shielded lens antenna having an aperture ten feet square which focuses the radio energy into a beam sharper than that produced by a searchlight. At the relay station the weak incoming signal is amplified and then retransmitted to the next relay station and so on to its destination. Plans are well under way for similar radio relay systems from New York to Chicago, Ill., and along many other routes.

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Experience With High-Speed Reclosing

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High-voltage transmission lines may be re-energized successfully following faults by correct application of high-speed relaying, according to recent experience on 114-kv lines.

IN the last decade considerable interest has been shown in the ultrahigh-speed reclosing of high-voltage transmission lines. Sporn and Muller have described operating experience over a 9-year period on 91 circuit breaker installations, the first of which was made in 1936.[1] The great majority of the American Gas and Electric system installations were made on 132-kv lines protected by ground wires. Single pole reclosing experience on 132-kv lines of the Public Service Company of Indiana was described by Trainor and Parks[3] in 1947. The purpose of this article is to present the results of $2^1/_2$ years' experience with high-speed reclosing of two 114-kv lines of the New York State Electric and Gas Corporation. These lines are constructed with wooden H-frames and the longer one has no ground wire protection.

GENERAL OBSERVATIONS

1. Due to present heavily loaded system conditions, high-speed reclosing generally will improve the service. This is especially true where generating plants are left with a local load above generating capacity upon the loss of a tie line. In this instance load otherwise must be dropped before resynchronizing. Likewise, a sudden drop from full load to a small load results in inefficient operation and extra stress on the steam generating equipment.

2. An investigation as to stability, transient shaft torques, relaying, and expected service improvement should be made prior to each installation.

3. Since the de-energized period cannot be shortened to less than 12 cycles, any further improvement in high-speed reclosing will result from the use of faster operating circuit breakers and single pole switching.

Essential substance of a conference paper, "Experience With High-Speed Reclosing of Transmission Lines," presented at the AIEE North Eastern District meeting, New Haven, Conn., April 28–30, 1948.

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THE SYSTEM STUDIED

The general arrangement of these lines with respect to the remainder of the 114-kv system is shown in Figure 1. The major part of the generation is from steam. Jennison station originally was connected to the remainder of the system by a single transmission circuit consisting of two line sections between the plant and the system. A network analyzer study indicated that single pole reclosing would not be required to maintain stability between the two systems. Therefore, to increase the reliability of this circuit, high-speed 3-pole reclosing was installed on both the Jennison–Norwich line and the Norwich–Westover section in 1945. The latter section is a 4-terminal line with reclosing at two terminals only—Norwich and Westover.

In the $2^1/_2$ years following this installation, 40 line faults have occurred, 31 of which were reclosed successfully. This is only 77.7 per cent successful reclosing as compared

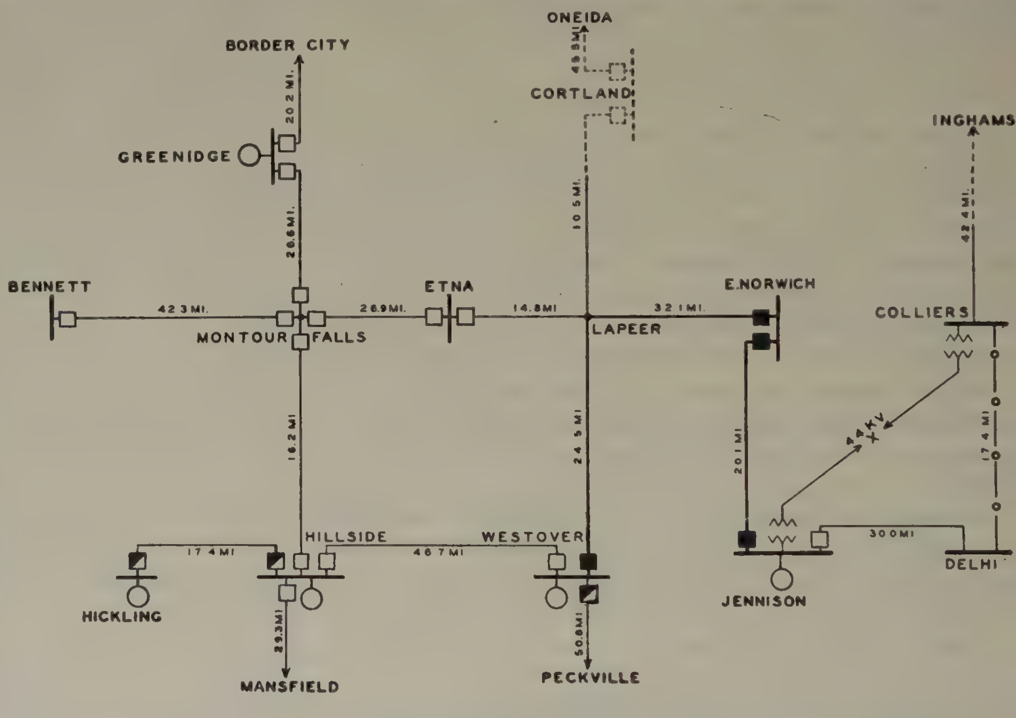

Figure 1. Ultrahigh-speed reclosing oil circuit breaker installations on the 114-kv transmission system of the New York State Electric and Gas Corporation

——— *New York State Electric and Gas Corporation lines*
- - - - *Foreign company lines*
——— *Line sections equipped with ultrahigh-speed reclosing circuit breakers*
■ *Ultrahigh-speed reclosing circuit breakers in operation*
◤ *Ultrahigh-speed reclosing circuit breakers under construction*
O *Generating sources*

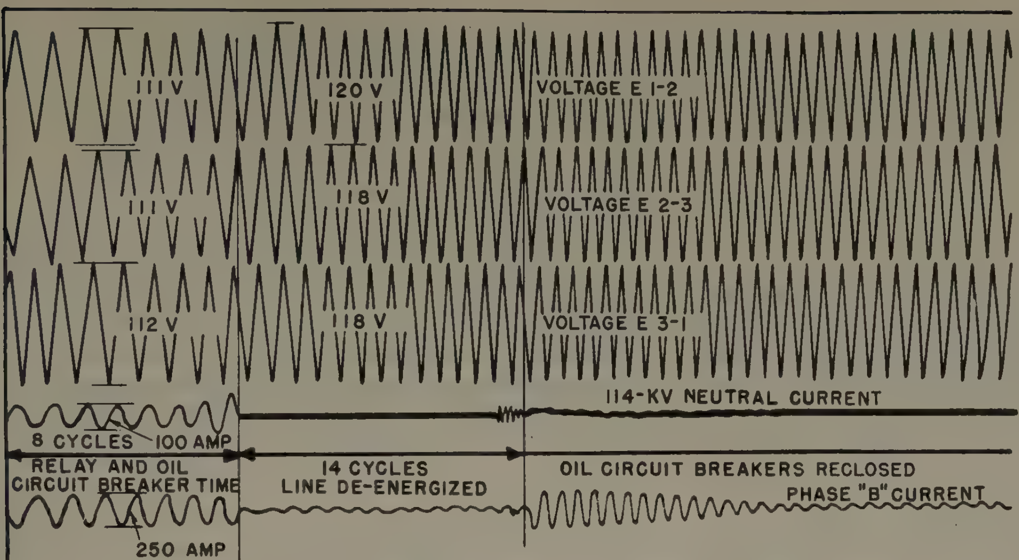

Figure 2. Successful reclosure—systems separated

tion, staged field fault tests and many more reclosing tests were made under the most adverse loading conditions attainable. A recent turbine generator inspection failed to show any evidence of damage to the machine involved.

A very similar installation of high-speed reclosing now is being made on the 114-kv circuit connecting Hickling station to the 114-kv system. A complete study of transient shaft torques was made for this installation using both the a-c network calculator and the transient analyzer. The results of this study[6] indicated that some of the medium voltage interconnections should be in service to prevent shaft torques above the manufacturers' guarantee of 3.25 itmes normal for repetitive duty and 4.35 times normal for non-repetitive duty.

High-speed reclosing of tie lines between generating stations and balance of the system with no other interconnections introduces some relaying complications. On the Jennison–Norwich line, negative-sequence phase-comparison carrier relaying is used and on the 4-terminal Norwich–Westover line, directional-comparison carrier relaying is in use. The staged fault tests showed that, because of the impossibility of re-establishing all 3-phase connections in a circuit breaker at the same instant, the relays received an indication of a ground fault although none existed, thus incorrectly retripping the circuit breaker upon reclosure. This was remedied in the case of phase comparison relays by using a low value of zero-sequence multiplier. In directional comparison relays three cycles of blocking was

with 90 per cent reported by Sporn and Muller. Based on their experience, we expect an increased proportion of successful operations in the future. It is of interest to note that 39 of the 40 operations occurred on the 82-mile line without ground wires and only one on the 20-mile line with properly designed ground wires. The construction of the two lines is similar in other respects. Reduced to a trip per line-mile basis, this gives a reliability factor of ten to one in favor of the overhead ground wires although no counterpoise is used.

Due to changes in power contracts and additional transmission lines, Jennison station with its local 44-kv system usually was operated in parallel with the system through other connections after July 1946. This afforded an interesting comparison of the virtues of high-speed reclosing under the two following conditions:

1. With only a steam generating plant, with a small local load at the end of a radial line.
2. With the reclosing of a tie line between two parts of a system held in synchronism by other lines.

From Table I, it may be observed that operation was 80 per cent successful without other interconnections and 77.1 per cent successful with other connecting lines in service. This indicates that the unsuccessful reclosures were not due to the loss of synchronism. This point also is verified by oscillograms. In the five cases of reclosure without other interconnections, the plant loading was reduced from full load to approximately half load.

Only one permanent fault occurred during this period and was due to an incorrectly formed compression line splice which had been in service 20 years. Two other faults occurred a few seconds after a successful reclosing operation. The reclosing relay, therefore, could not function as its timing capacitor did not have time to recharge. Eliminating these cases, where successful reclosure was impossible, we find 84 per cent successful operations.

Some concern was felt that the shaft torques developed in the turbine generator shaft might be dangerous. This point was checked with the designers who agreed that the shaft would withstand the strain. Following the installa-

Table I. Experience With 20-Cycle Reclosing of 114-Kv Lines

August 1, 1945, to January 1, 1948

Line	Total	Successful	Unsuccessful	Per Cent Successful
All line faults				
Jennison–Norwich	1	1	0	100
Norwich–Westover	39	30	*9	77
	40	31	*9	77.7
With other interconnection				
Jennison–Norwich	1	1	0	100
Norwich–Westover	34	26	*8	76.5
	35	27	*8	77.1
Without other interconnection				
Jennison–Norwich	0	0	0	
Norwich–Westover	5	4	1	80
	5	4	1	80

* Includes five restrikes, one permanent fault, and two cases where timing capacitor was not recharged and ready for reclosing.

applied along with each high-speed reclosure to allow this transient effect to die out.

The oscillogram, Figure 2, shows the resynchronizing current to be of the same order of magnitude as fault currents which results in the operation of the carrier starting relays. Some effect of the irregular re-establishment of circuit breaker contacts is shown in the "114-kv neutral current" trace.

Tests have shown that the incorrect phase comparison relay operations referred to in the foregoing were the result of the difference of transient response of supposedly similar bushing current transformers and not of inherent relay design.

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Fluoroscopic X-Ray Image Amplifier

A fluoroscopic X-ray image amplifier now being constructed at the Westinghouse Research Laboratories is based on information gained in four years of intensive study resulting in the actual amplification of an X-ray image. Basically it will consist of a high vacuum tube that electrostatically focuses and accelerates an electron stream. When perfected, the device will take the form of an attachment for standard fluoroscopic equipment.

In present-day fluoroscopy, the physician must dark-adapt his eyes for 20 minutes. Even then with the low brightness available in most difficult cases, such as a large abdominal thickness where the brightness may be as low as 0.00005 millilambert, a separation of 1/4 inch is necessary before contours can be distinguished. Furthermore, this 1/4-inch figure applies only in measurements where the contour lines separate regions with a contrast of 100 per cent as in contours between black and white. While this is an extreme case it compares with 30 millilamberts brightness and 0.001-inch contour separation as normal conditions for observing X-ray plates. A brightness of 0.001 millilambert with a required contour separation of 1/32 inch is about the center of the fluoroscopic range.

The new image amplifier increases the brightness of the fluoroscopic image after the X-rays have passed through the patient. This solution to a long felt problem is necessary because the X-ray intensities are already at the patient's tolerance level and is possible because the sensitivity of the physician's eyes are the main limitation to effective fluoroscopy today. Fluorescent screens now have a gross efficiency of about three per cent so that even a theoretically perfect screen would be only about 30 times as bright. Thus screen improvement alone cannot achieve the desired brightness gains.

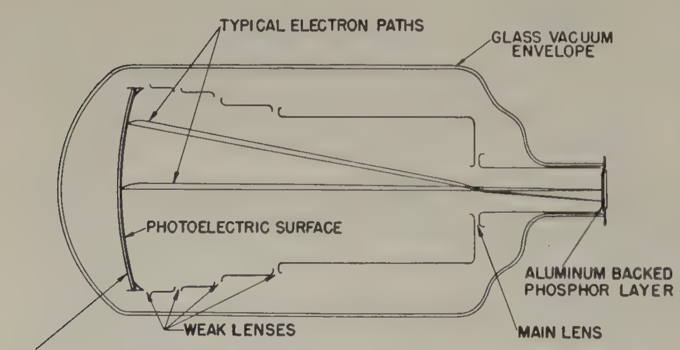

Figure 1. X-ray image amplifier

With the image amplifier tube attached to his equipment he still may have to dark-adapt his eyes, though for only three or four minutes, before he can see all the details. Increased brightness of the X-ray image has been attained by converting the X-ray quanta into light with a fluorescent screen and thence to electrons by means of an adjacent photoelectric surface. These electrons are accelerated by a high potential placed across the vacuum tube, giving a brightness gain of 20 times. A further factor of 25 in brightness gain is attained by electrostatic focusing of the electron stream to reduce the image to one-fifth of its size. The reduced image, now brightened 500 times, impinges on a phosphor output layer that converts it back to a visible image. The visible image is observed through a conventional optical system that magnifies it by a factor of five back to its initial size. The tube is shown in Figure 1.

The future possibilities for fluoroscopy with the addition of amplification are manifold. Both patient and doctor will save time and cut down on the length of time they are exposed to direct and scattered X-rays. In addition to shorter examinations such techniques as the use of the wafer grid, stereofluoroscopy, and even the televising of fluoroscopic images well may become practical. All these possibilities are in addition to the great advantage that the physician will be able to perceive objects at present indiscernable.

The image amplifying system is just emerging from the research stage. Many months of perfection and design engineering remain to be done before the device is commercially available. The research has, however, irrefutably proven the practicability and immense importance of the device.

The Bellingham Hydraulic Log Barker

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PRODUCTION of the higher grades of wood pulps requires that the bark be removed from the logs as the initial process in preparing the wood for manufacture into pulp. Phenomenal savings in pulp wood and labor are being realized by Pacific Northwest pulp and paper mills using full-sized-log debarking machines, capable of debarking logs 6 to 80 inches in diameter, by 26 feet long. The success gained with this latest Bellingham barker has resulted in marked attention being given to additional installations of this design in both large and small capacity. The older wasteful methods of debarking small cut-up sections of the tree are becoming obsolete.

Three other types of big-log hydraulic barkers preceded the Bellingham type during the past five years, all of which are in successful operation. These are the lathe, log indexing, and segmental ring types. These barkers all use high pressure water directed against the log by a nozzle. By electric controls, the nozzle and log are moved so that the full area of bark is covered. The powerful jets blast away the bark, leaving a clean log surface. A "barkerman" is required to manipulate the controls.

In the Bellingham barker the log is supported in and rotated by two sets of trunnion rolls, as indicated in Figure 1. The nozzle traverses the log axis. The principal advantages of the Bellingham barker are the ease and speed with which the barkerman can manipulate the machine to bark the variety-of-woods logs. In addition to the perfect specimens these include those with oversize or elliptical butts, rotted sections, splits, crooks, and other crippled forms. The barkerman controls all machinery movements required.

Multistage high-pressure induction-motor-driven centrifugal pumps are used to feed the nozzle. Six-inch nozzle barkers require about 500 horsepower to drive the pump while a 24-inch nozzle requires at least two 800-horsepower pump sets, but under some conditions steam turbines may be justified.

The log roll motor must be capable of starting, revolving, and tumbling logs of all shapes and sizes within the capacity of the barker. The trunnion speed will vary from a "creep" for the largest poorly shaped logs to a maximum of about 40 rpm. A d-c reversing adjustable-speed shunt motor and gear unit, powered from a reversible-polarity adjustable-voltage generator, provides the most satisfactory drive for the larger units. A similar selection is made for the carriage drive motor, which is connected to the load through a speed reducer and propulsion cable drum.

It is necessary to adjust the nozzle distance from the log for most effective barking. This may be done by hydraulic or air cylinders, lead screw and motor mechanism on the carriage, or by traveling cable arrangement to a stationary motor and drum unit apart from the carriage. The first method presents no particular electrical problems, the others require special consideration as regards application of the motors because of the frequent starting required. The highest speed nozzle drives may require from 8 to 15 nozzle adjustments per minute. The time interval that the motor runs is very short and little cooling is afforded by rotation. Ordinary induction motors are satisfactory, but may require forced air cooling.

The barkerman's controls should be designed to minimize both physical and mental fatigue. The variability of log sizes and their conditions greatly multiply the complexity and co-ordinated handling requirements with which he continually must deal. It is usually preferable to use control levers to set speeds and operations not requiring frequent change and to use top-of-lever push buttons for controlling the more frequent motions.

The success attained to date with this barker indicates that modifications in design and arrangement will be numerous to suit the additional requirements of very small and very large log debarking. It also is expected that the barker will find use in other industries and sections of the country. A particularly attractive application is in large saw mills, to remove the bark prior to the logs reaching the head saw, to improve the yield in lumber, conserve by-product pulp wood, and reduce saw maintenance.

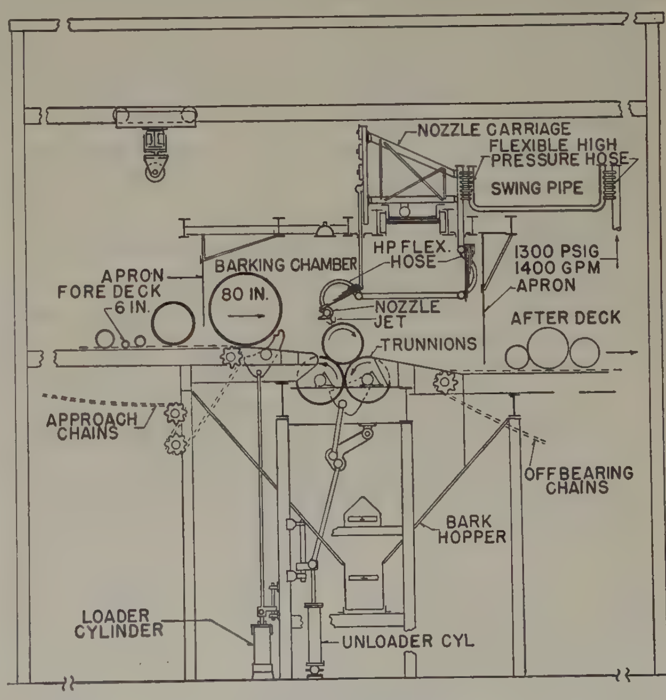

Figure 1. Typical layout of Bellingham-type barker plant

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Telemetering Circuits—Metallic and Carrier

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THE ART of telemetering has enjoyed a steady development for 30 years. The increased number of power system interconnections and the increased operating efficiency that is to be gained by use of automatic load control warrant careful study of the circuits that are used to transmit the required information. It is expected that as telemetering systems expand more multicircuit carrier channels will be used. Protective relay and communication circuits will be combined with telemetering circuits. Space radio probably will be added to provide trunk line service for communication, telemetering, supervisory, and protective relay control in locations that cannot be served economically by other means.

Power systems that are concentrated in metropolitan areas, and have few interconnections, generally use telemetering circuits similar to those illustrated in Figure 1, which illustrates the measurement, transmission, and recording of power and reactive volt-amperes throughout a power system. The information is placed in front of the load dispatcher to guide him in controlling operation of the power system.

Larger systems that include widely separated generating stations are served better by telemetering circuits that are somewhat different but it generally is found that extensive telemetering systems include elements of both. Generating plants that are located in and close to cities frequently require short links between points of measurement and local dispatching offices where the information is gathered for trunk line transmission to the system dispatcher's office. An economical solution to these problems requires consideration of all telemetering systems.

Telemetering transmitters can be divided into three classifications: voltage, current, and impulse. The voltage and current types must be linked to their associated receivers through twisted pairs of wires, enclosed in lead sheaths or similarly protected to exclude disturbing voltages that usually originate in power system faults. Impulse transmitters are less subject to interference by voltages that are introduced into metallic circuits by induction and rise in station ground potentials. However, their principal use is in connection with carrier frequency transmitters.

Carrier frequency circuits can be classified as single function or single frequency circuits, tone modulated circuits, protective relay circuits, and single-side-band circuits. Frequently all types will be needed to build an efficient telemetering system. As indicated in Figure 1, separate metallic circuits are required for transmitting measured information by use of the thermal converter, which is typical of the voltage-type transmitter. Impulse transmitters are used to key a number of audio frequency tones for transmission over a single pair of wires or over a single carrier channel. Other systems may use single-side-band tone-modulated carrier transmitter–receivers in a telemetering and load-frequency control circuit; only two carrier frequencies are required.

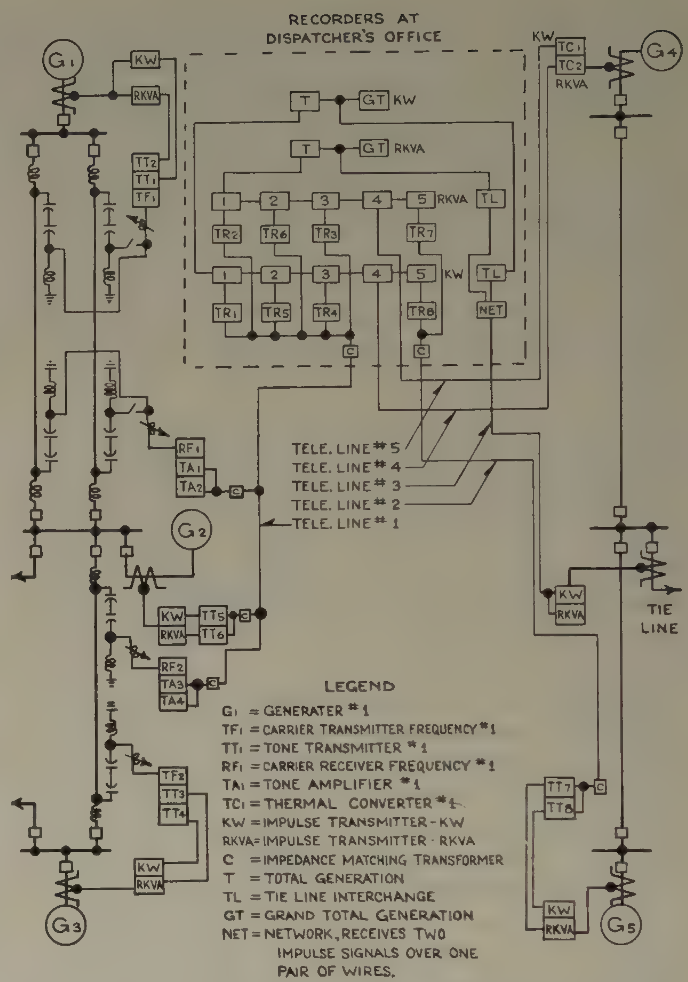

Figure 1. Block diagram of telemetering circuits using metallic and carrier circuits

To obtain most efficient use of the carrier frequency spectrum for telemetering, load control, protective relay control, and communication, all types of circuits must be used. It is expected that future installations will make greater use of multichannel circuits. Tone modulation of carrier channels and joint use of carrier equipment provide economies in use of material and carrier frequency spectrum that cannot be overlooked. These circuits probably will be linked by space radio in locations where service requirements and physical limitations permit.

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Snow Static on Aircraft

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Dependence of airplanes on static-free radio reception gives critical importance to the process of electrostatic charging by friction with ice crystals and snow particles, which produces corona discharge and resulting radio interference. Several methods have been proposed for the elimination of static with varying results. One, described here, is neutralization of the charge by artificially activating negative corona discharges of a type that does not interfere with radio reception.

IT IS generally recognized that the most serious form of precipitation static on aircraft is snow static, which is due to electrostatic charging of the aircraft by friction with ice crystals and snow particles. Although the corona currents from the aircraft resulting from this kind of charging do not reach the large momentary values which can occur when the airplane flies near or through charged clouds like those which occur under thunderstorm conditions, the corona resulting from ice crystals and snow frequently blanks out all radio reception on an airplane for long enough times for the pilot to get entirely off course and into trouble. Conversely, frequent enough interludes of reception usually occur between bursts of static under charged cloud conditions to enable the pilot to recognize range signals and keep on course. This article will be confined to the more serious navigational hazard, snow static.

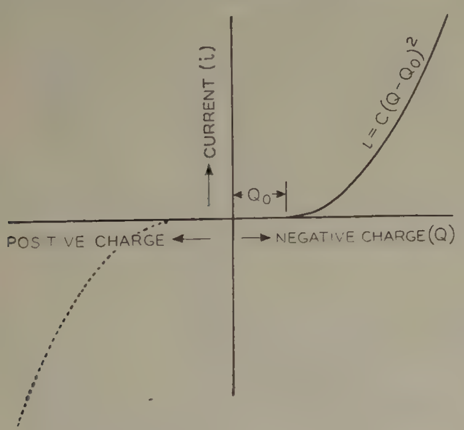

Figure 1. Current discharged from an airplane as corona, as function of the accumulated charge on the airplane

Prior to 1941, some excellent work was done to reduce the radio interference caused by snow static. The shielded loop antenna was developed by Transcontinental and Western Airlines and reported by Morgan.[1] The trailing wire discharger was studied by United Airlines and reported by Hucke[2] in 1939. Each of these developments produced a definite and demonstrable improvement in radio reception under snow static conditions.

From about this time until 1943, the writer conducted extensive flight researches on the problem, but could not carry the problem to a final conclusion because an adequate type of airplane could not be obtained for this project on the grounds that this was "long-range research." Thus this work remained as a report instead of a finally developed device when the writer went overseas in 1943.

At this time, a joint Army-Navy Precipitation-Static Project was organized primarily to overcome the resistance of the Army Air Forces to assigning adequate aircraft to the problem. The writer was surprised, to say the least, to find upon his return from overseas duty that the group on the Army-Navy project had ignored his previous work entirely and taken off on other approaches to the problem.

The conclusions as published by the Army-Navy group[3] as regards snow static were that the so-called "wick dischargers" in combination with a polyethylene-insulated wire antenna constituted a solution of the problem, and it was directed that military aircraft be so equipped. That these could not possibly be even as effective as the methods developed prior to 1939 can be seen from the following.

The easiest way to dispose of the wick is to draw attention to some recent measurements made by Beach[4] in which it is demonstrated

1. That wicks cannot relieve an airplane of nearly as much static charge as could an equal number of sharp metal points.
2. That the interference with radio reception caused by any discharge from a wick is just as severe as an equal *discharge current* from a sharp metal point.

The writer is indebted to Beach for publishing those experi-

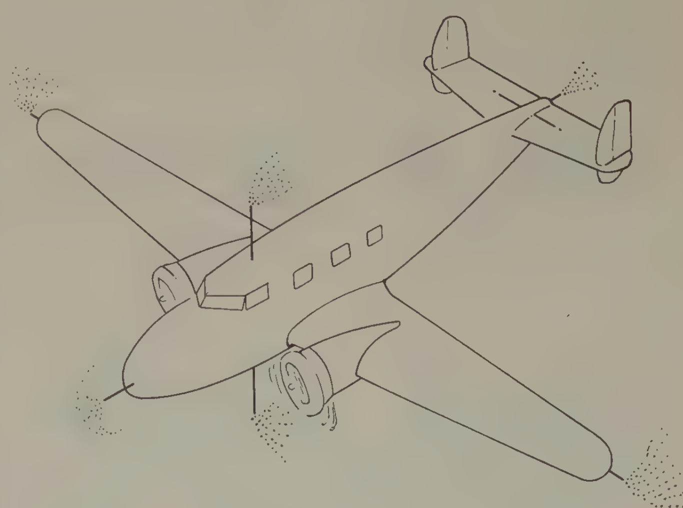

Figure 2. Location of sharp pointed metal probes used in flight tests

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Report of work performed while at the Electronics Research Corporation, 1937–41, and during active duty as major, Signal Corps, at Wright Field, Ohio, 1941–43.

ments as otherwise a lengthy analysis of some of the writer's earlier experiments on corona discharge would have been needed to prove the same conclusions.

With respect to the polyethylene-insulated wire antenna, it should be appreciated that the housing about the shielded loop antenna is a conducting surface whose radius of curvature is of the order of inches, and that the shielded loop is mounted near the fuselage. Although the loop obviously cannot support corona discharge at all, nevertheless, reception is lost on the loop soon after it is lost on the wire antennas as one is flying into increasingly severe snow static conditions, as has been well known since 1936. The writer is entirely at a loss to understand how the Army-Navy group could expect an *insulating* sheath of *greater* curvature in a *more exposed* position to result in reception which is even comparable with that from a shielded loop antenna.

Although these arguments would seem conclusive, nevertheless the electronics subsection at Wright Field recently

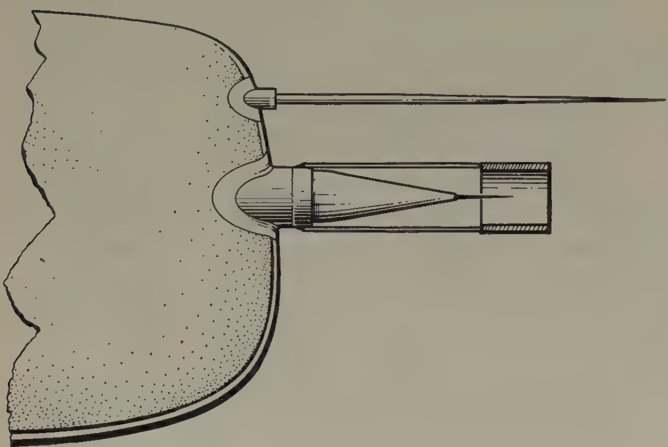

Figure 3. Tail probe, and charger, mounted on the tail cone

has refused to complete the tests proposed by the writer and interrupted in 1943. For this reason it is believed of interest to summarize the work and to present the nature of the proposed final tests in order that any airline or other interested agency can proceed if it so desires.

NEGATIVE CORONA

The polarity of the electric charge received by an airplane in flight is snow static conditions in general is negative.

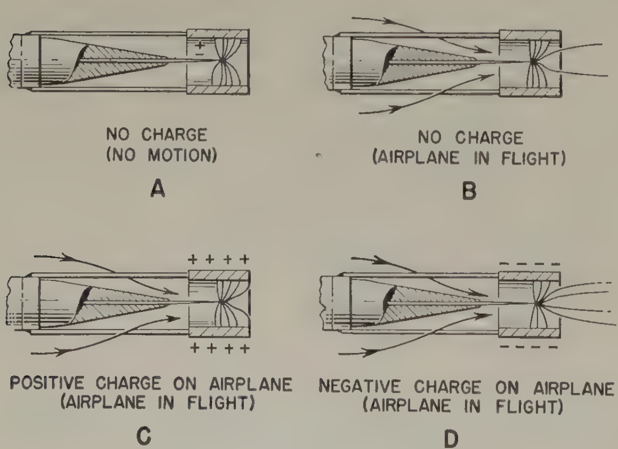

Figure 4. Operation of the charger

This charging continues at a rate which is independent of the amount of negative charge already on the airplane and depends only upon the impact conditions of the particles and the airplane.[5,6] Unless other provision is made, this negative charge accumulates until it discharges as corona from exposed wires, corners, and edges on the airplane, and

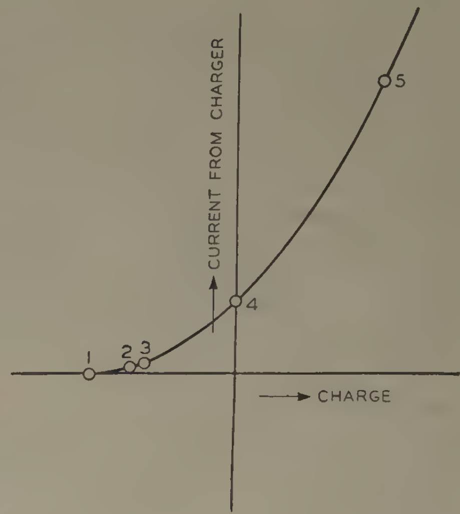

Figure 5. Current-charge characteristic of the charger

causes the interference with radio reception known as snow static.

The characteristic features of the negative corona discharge have been published.[7,8] It has been demonstrated that the ionizations which produce practically all of the negative charge in the negative corona from a point occur in a hemispherical shell concentric with the center of curvature of the tip of the point, and that the thickness of this ionization cap is about the same for the sharpest points that can be produced for laboratory studies as it is for points and wires of the kinds occurring in exposed places on an air-

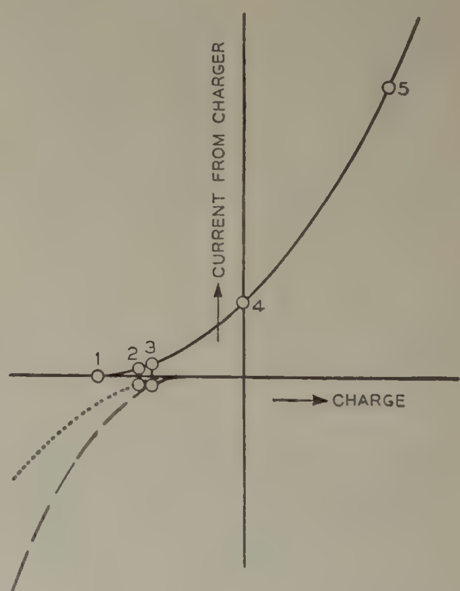

Figure 6. Current-charge characteristic of the charger and the discharge characteristics of the airplane with wood (dotted line) and metal (dashed line) propellers, respectively

plane. The electrons produced at the discharging wires and points combine immediately with oxygen molecules to form negative molecular oxygen ions whose mobility has been measured and is 2 centimeters per second per volt per centimeter. It has been shown further that the potential drop through this ionization and attachment sheath remains of the same order of magnitude while the sharpness (inverse radius of curvature) of the discharge point or wire is varied by a factor of 100 (reference 9).

The negative ions arising at the sheath boundary provide a space-charge-limited current which can be calculated as

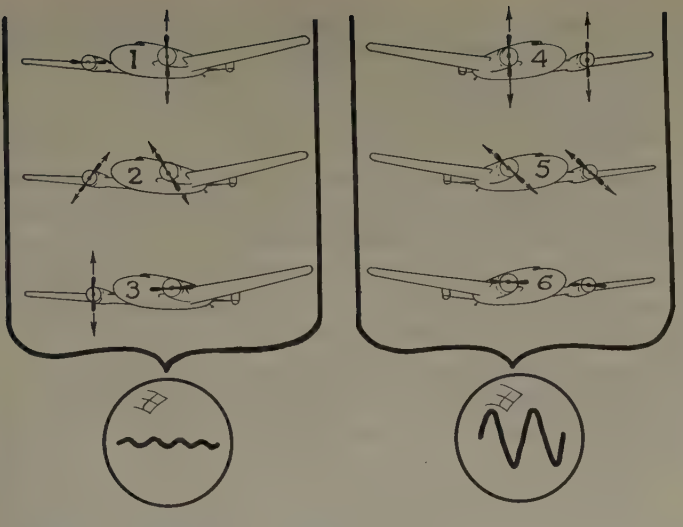

Figure 7. Diagrams to explain variation of probe current in synchronism with the variation of the sound intensity from propellers and engines

follows. The mobility of the negative ions is K in

$$u=KE$$

where u is the velocity of drift of the ion, K equals 2 centimeters per second per volt per centimeter at normal pressure and temperature, and E is the electric field intensity. The direction of drift in this case is always the same as the direction of the electric field and is different in this respect from the motion of electrons or ions in vacuum.

The current–voltage relationship for the corona discharge can be derived by a method similar to that used before.[10] Considering the region between the sheath boundary and any collecting electrode of any shape whatsoever, suppose

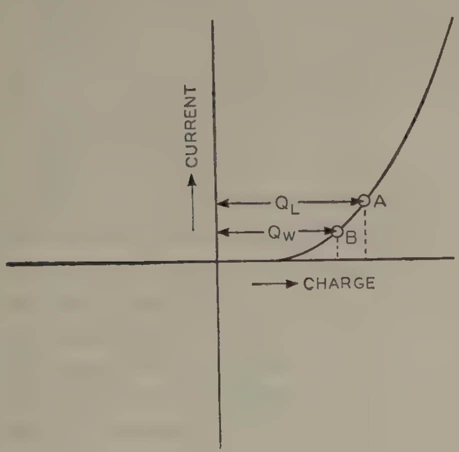

Figure 8. Discharge curve for an airplane used to define the limiting charge for radio range reception

that there is an electric potential distribution $V(x,y,z)$ which is a function of position, and represent the potential at the sheath boundary by V_0 and the potential at the collecting electrode by V_1. During the steady state condition being considered, the charge distribution between the sheath boundary and the collecting electrode satisfies Poisson's equation

$$\rho=\frac{1}{4\pi}\Delta^2 V$$

where ρ is the charge density. We now increase the potential by a constant factor a everywhere, and produce an increase in the charge density everywhere by the same factor, thereby obtaining a new field distribution which again satisfies Poisson's equation because

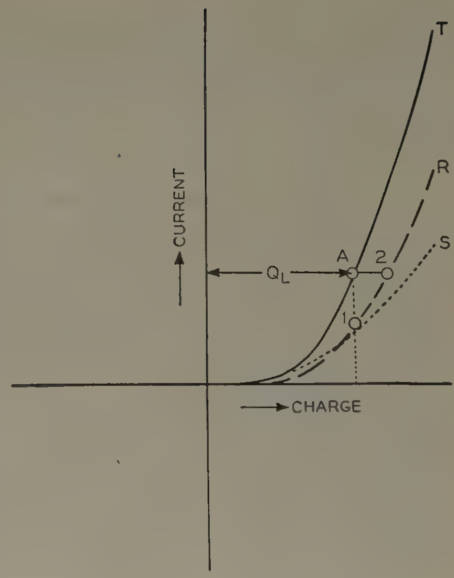

Figure 9. Improvement in the discharge curve for an airplane produced with trailing wires and sharp metal points

$$a.\rho=\frac{1}{4\pi}\Delta^2(aV)$$

The total current flowing can be found by integrating the current density over any equipotential surface. If i is the current density

$$i=\rho.u$$

where i has the same direction as u which has the same direction as E and so is normal to the equipotential surface everywhere. The total current is

$$I=\int\int_s i\,dS=\int\int_s \rho\,u\,dS=\int\int_s \rho\,KEdS$$

where the integrations are over the equipotential surface. After the potential is increased by the factor a, the current is

$$I_a=\int\int a\rho KaEdS=a^2\int\int \rho KEdS=a^2I$$

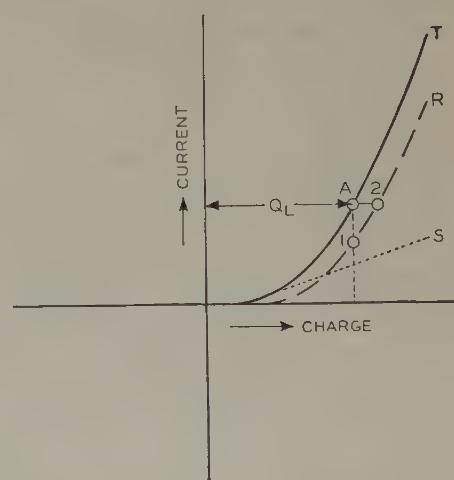

Figure 10. Improvement in the discharge curve for an airplane produced with wick dischargers

From this it is seen that the space-charge-limited corona current is proportional to the square of the factor by which the voltage difference (V_1-V_0) between the sheath boundary and the collecting electrode is increased. This relation of course is true regardless of the shapes of the electrodes. The relation can be written

$$I=A(V_1-V_0)^2$$

where A is the proportionality constant. If V_1 is the potential difference applied between the electrodes, it follows that V_0 is the potential drop through the sheath which as mentioned before is constant to a first approximation for all corona electrodes.

CORONA DISCHARGE FROM AIRCRAFT

In considering the space charge limitation of corona current from an airplane in flight, it must be appreciated that the electric field due to the charge on the airplane diverges all the way to the collecting electrode which may be the ground, and further that the most rapid divergence occurs near each discharging point on the airplane. In fact, the region near the sheath boundary exerts the principal effect by controlling the ionization by avalanches as is discussed in detail in the references.[7,8]

The electric field at every point on the airplane is propor-

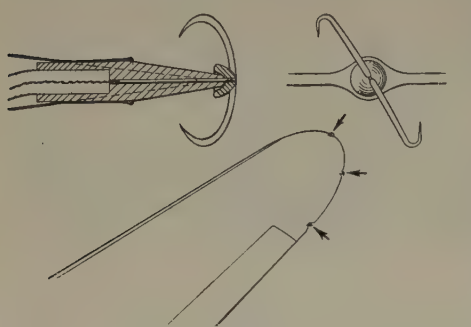

Figure 11. Charging dischargers mounted on trailing edges

tional to the total charge on the airplane, except for the small redistributions near the discharging points due to the space charge. Thus, for the potential drop through a distance equal to a sheath thickness to exceed the minimum voltage V_0, the airplane must accumulate a minimum charge Q_0 which is proportional to V_0, after which the corona current is proportional to $(Q-Q_0)^2$ where Q is the total charge on the airplane. The equation for each point has the form

$$I=B(Q-Q_0)^2$$

where B is the proportionality constant. The total dis-

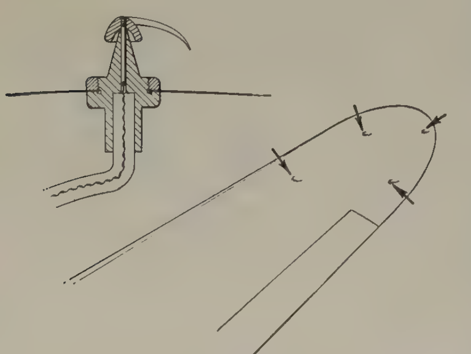

Figure 12. Charging dischargers mounted on surfaces near extremities of the airplane

charge current from the airplane is then the sum of such terms for all the discharging areas where the contribution of each discharge wire or point is proportional to the area of its sheath boundary and not its own actual area. The value of Q_0 which determines the total charge on the airplane necessary for each point to go into corona varies with the position on the airplane. However, the contribution to the total corona of dull points and of points well inboard is reduced by the larger value of Q_0, so to a good approximation, the total corona current from the airplane is given by

$$I=C(Q-Q_0)^2$$

Such a curve representing the current discharged from an airplane as corona as a function of the total charge Q on the airplane is shown with the solid line in Figure 1 as a parabola $i=C(Q-Q_0)^2$ with the point of tangency to the Q axis at Q_0. If the airplane were to acquire positive charge, the dependence of current and charge would be like that shown with the broken line, which for corona in air has very nearly the same form as that for negative corona but with polarities reversed. For some gases other than air, large differences do occur, however.[10,11]

Increasing the speed of the airplane or increasing the size of the airplane increases the current at each value of charge and so expands the current scale, but this does not change the result that the form of the curve is approximately a parabola with a nonzero point of tangency. This result

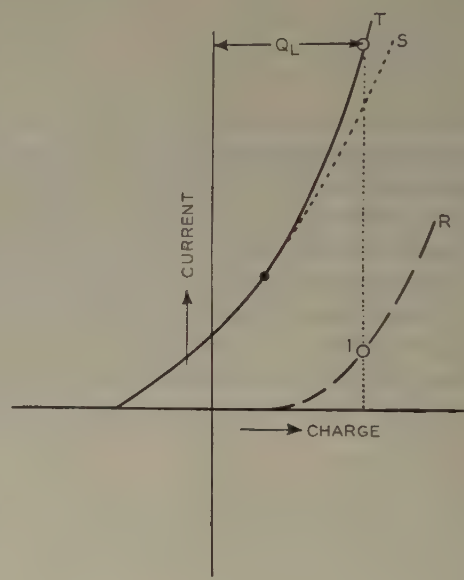

Figure 13. Estimated improvement in the discharge curve for an airplane produced with charging dischargers

has been confirmed by flight tests and also has been confirmed by the curves published by other investigators[12] although those investigators did not interpret their curves in this way.

EQUIPMENT FOR FLIGHT TESTS

In most of the flight research conducted in 1941–43, the airplane was equipped with sharp pointed probes in opposite directions on three mutually perpendicular axes as illustrated in Figure 2. Connection with each probe was made to ground through a *991* tube shunted with a capacitor so that the flashing rate of the tube was a measure of the current. Which of the two half circular electrodes flashed indicated the polarity of the current. The sensitivity was better than one microampere for each probe circuit. A steadily moving photographic film in a modified motion-picture camera was used to record the flashing tubes. Simultaneous recordings could be made of currents to other attachments as required by the study in hand.

This kind of installation was used in order to distinguish between true snow static and any effects due to nearby electrically charged clouds, a precaution which other observers generally have failed to take.

A typical probe is shown attached at the end of the tail

cone in Figure 3 and below it in that figure is shown a partial section of the artificial charger used in these experiments.

The probes were adjusted for length so that when the plane was flown in absence of snow or charged clouds and was being charged using the charger, each probe discharged the same current. For this balance, the wing tip probes were about two inches long, the nose and tail probes about one foot long, and the top and bottom probes were about five feet long.

CHARACTERISTICS OF THE CHARGER

The operation of the charger is illustrated in Figure 4. Corona from the sharp-pointed electrode is produced towards the coaxial cylindrical surface by use of a high voltage rectifier. The rectifier was a particularly simple and hardy one using a gas-filled cold-cathode type of tube.[13] Figure 4*A* shows the direction of motion of the ions when the airplane is at rest, as, for example, when standing on the ground. All of the ions, which of course have the same polarity as the pointed electrode, are collected by the cylinder.

The situation in flight, when the charger is first turned on, is illustrated in Figure 4*B*, where it is shown that the movement of air through the cylinder changes the direction of motion of ions somewhat, and some of the ions are blown away from the airplane, leaving a charge on the airplane opposite in polarity to that of the sharp electrode. This charge accumulates on the airplane. If there were no places on the airplane from which this charge could leak off as corona, a situation would be reached such as shown in Figure 4*C* where the air is trying to blow ions away but the charge of opposite polarity on the airplane draws these ions back and does not allow them to escape.

An analysis shows that the current which the charger delivers to the airplane as a function of the charge accumulated on the airplane is like that shown in Figure 5. This is a theoretical curve and the values of the numerical scales for each of the two co-ordinates would depend on the size of the charger and the speed of the airplane. Point 3 is the condition of charge corresponding to Figure 4*B* when the charger is first turned on in flight.

As the airplane becomes charged, the ion flow approaches that shown in Figure 4*C*, and the current will go clear to zero as at point 1 in Figure 5, unless the charge can leak off as corona.

The same curve is shown in Figure 6 and in addition, the discharge curves are given as broken lines for the airplane equipped with compressed-wood propeller blades and with metal blades, respectively. In each instance, the accumulated charge on the airplane reaches a steady value where the current supplied the airplane is just equal and opposite the current leaking off the airplane as corona. Point 2 is the condition where the charging current equals the discharge current with wood propeller blades.

That the theoretical curve of Figure 5 is consistent with observations made in flight can be seen as follows. Point 1 is the condition of charge which would be reached if no corona occurred from the airplane as illustrated in Figure 4*C*. Point 2 is the condition attained in flight tests when wooden propeller blades were used. It was observed in flight that the total of the current from all the probes was just equal and opposite to that from the charger. Point 3 represents the condition with metal propeller blades. In this case it was observed in flight that the current from the charger was a little greater than that from the probes. Point 4 represents the initial value of current when the charger is first turned on as illustrated in Figure 4*B*. It was observed in flight that the charger current meter received a large ballistic throw the instant the charger was turned on, following which the charging current assumed the steady value which was lower. When the airplane was flying at about 10,000 feet in fine snow at temperature about 0 degrees Fahrenheit, the charger current was greater than 50 microamperes, the limit of the meter being used. A point 5 in Figure 5 represents this situation which corresponds to Figure 4*D* with the pointed electrode in the charger held at a negative potential.

Although this charger was designed for use in fair weather, these observations suggested a modification which will be described later for a more nearly ideal method for eliminating snow static.

CORONA FROM PROPELLER TIPS

After the lengths of the probes were adjusted so that each discharged equally when the charger was used in clear weather, the airplane with metal propeller blades was flown in ice crystals and snow. In one test, the total current from the probes was put through a resistance and the potential drop in the resistance measured with a cathode ray oscillograph. It was observed that the current from the probes varied at about 60 cycles and that the amplitude varied between zero and a maximum. This variation in amplitude kept time with the variation in sound intensity from the two propellers, due to lack of exact synchronism of the two motors. As the pilot readjusted the throttle setting from time to time, this beat frequency in the sound amplitude from the two motors changed from about one per five seconds to about two per second, and the variation in the amplitudes of the wave form on the oscillograph kept up with each variation in beat frequency.

In order to understand this observation, Figure 7 should be examined. Supposing that the current collected by the airplane by friction remains constant, the current from the probes must vary oppositely to the current from the rest of the airplane. The only parts of the airplane whose exposure to corona-inducing fields is varying at this frequency are the two blades on each of the two propellers whose speed was about 1,800 rpm (actually 1,770–1,820) and hence whose frequency of exposure was just the frequency observed 60 cycles per second. The variation in current from the probes was just the variation in deficiency of current from the propellers due to their motion between vertical and horizontal positions. While the propellers are parallel, the corona from the propeller tips should vary a maximum amount, and when the propellers are in directions at right angles, the variation should be a minimum except for a possible second-order 120-cycle variation.

From this observation together with the fact that the charger current for clear weather is smaller when wooden propeller blades are used than when metal propellers are

used at the same speed, it was concluded that the propeller tips provide an important part of the total corona discharge from the airplane. This is to be expected for several reasons. The propeller tips are thinner and have sharper edges than most other parts. There is a partial vacuum near them, and the mobility of negative ions increases with the decrease in density of the air. A last and probably greatest distinction is that the propeller tips are moving at a speed much greater than the rest of the airplane and consequently the space charge limitation of current may be modified appreciably by the tendency of the blades to move away from the space charge while this kind of effect does not appreciably modify the space charge relation for other sharp places on the airplane.

One of the observations on the corona discharge made in laboratory studies[14] was that negative corona changed over from the radio-silent form to the interfering form at a much lower current from an edge than it did at a point with the same radius of curvature.

It is concluded that the principal source of interference on the shielded loop on an airplane in flight in snow is corona from propeller tips. Such a conclusion obviously could not be tested on an airplane suspended on string insulators in a hangar and raised to a high voltage, so the tests made in a hangar by the Army-Navy group are believed to be inadequate, and their conclusions disregarding the propeller tip discharges unjustified.

GENERAL RELATIONSHIPS

As mentioned earlier, the static interference on the wire antennas becomes too severe to permit reception of range signals before it becomes too severe on the shielded loop antenna. It is common practice when flying into increasingly severe snow static conditions for a pilot to switch to the loop when reception becomes impossible on the wire antennas. By doing so, the pilot gains a little additional time during which he can read the range signal before he loses all use of his radio.

This can be related to the discharge curve for the airplane as follows: In Figure 8 is shown a parabolic discharge curve like that shown in Figure 1. Increasingly severe snow static conditions correspond to moving along the curve, away from the origin. At some point *B* the interference becomes too severe to permit reception on a wire antenna, and at a larger value of friction charging current, as at point *A* the loop becomes impossible to use.

From the familiar theorem of electrostatic field theory, the field intensity on each point on the airplane is proportional to the total charge on the airplane. Thus the corona discharge from each point on the airplane is fixed by the electric field at that point on the airplane, which in turn is fixed by the total quantity of charge on the airplane. In this way it is seen that the limiting condition for use of the loop antenna is that the total charge on the airplane must remain less than the quantity Q_L which is the abscissa of the point *A* in Figure 8. Similarly, the limiting charge Q_W pertains to the wire antenna, and is a smaller quantity.

In this curve and in following curves, the numerical scales will depend on the type of airplane and the speed at which the airplane is flown. An estimate of magnitudes for a *B-17* can be obtained by seeing a curve published by some of the Army-Navy group.[12] However, the point of this discussion involves only relative values and not absolute values. Numerical scales will not be needed for showing the relative positions of curves and critical points on those curves, so scales will not be put on Figure 8 and those which follow.

In Figure 9 the same curve as shown in Figure 8 is represented with the dashed line *R*. Suppose that the airplane is equipped with a trailing wire, and with a number of sharp points on the extremities, and suppose that the current discharged by these wires and points is represented by the dotted line *S*. The total current which is discharged by the airplane and the wires and points together is then necessarily the sum of the ordinates of the two curves and is represented by the curve *T*. If the trailing wires and metal points are sharp and spaced far enough from each other, they will produce negligible interference with radio reception, and the only corona discharges which prevent radio reception are the same discharges which did it on the untreated airplane as discussed in connection with Figure 8. Consequently, it is seen that the point on the solid curve *T* in Figure 9, at which all radio reception on the airplane becomes lost, is the point where the abscissa is the same value of Q_L which applies in Figure 8. From this it is seen that providing the airplane with trailing wires and sharp points has increased the tolerable snow static current pickup from point 1 to point 2 along the curve *R*, which represents a small improvement.

In a like manner, one can examine the effect of hanging numerous "wick dischargers" on an airplane as illustrated in Figure 10. Here again, the dashed curve *R* represents the untreated airplane. The dotted line *S* representing a large number of wick dischargers is drawn as a straight line and not as a curve. Not only does analysis of Beach's observations show that this is a proper representation, but examination of a curve published by the chief proponents of the wick[15] shows the same thing. Although those authors tried to force a curve into the data, examination of the experimental points shows that the data fit a straight line much better than a curve. In this case the improvement is less than would be obtainable with trailing wires and sharp points.

It is entirely conceivable that with any of these static eliminators, such as trailing wires, sharp points, or even wick discharges, one could search for and occasionally find some weather where the airplane is picking up a friction charging current of more than the ordinate at point 1, but less than the ordinate at point 2. In such weather on that particular day and in that particular locality, one could place the static eliminator in operation and take it out of operation and provide a most impressive demonstration for an uninitiated observer whose only observation is what he hears on the headphones. The demonstration would be very impressive because the interference with radio reception begins at a discharging current which is only a little less than the discharging current at point *A* where radio reception has become impossible. However, such a demonstration would not give an adequate measure of effectiveness in terms of the significant variable for weather conditions in

general. Measurements of any static eliminator rather should be referred back to the maximum value of Q_L which the eliminator will permit the airplane to acquire under the most severe snow static conditions which the airplane can encounter.

PROPOSED METHOD

The method which the writer is proposing for the elimination of snow static consists in artificially activating negative corona discharges in the slip stream, of the type which does not interfere with radio reception. This has the effect of neutralizing far more charge than any previous method as will appear from the following. The kinds of installation which should be tested are illustrated in Figures 11 and 12. Sharp metal points with tips held at about a half inch from the metallic airplane surface are raised to a negative direct potential through a resistance of 10^7 to 10^9 ohms connected to a rectifier delivering 5 to 10 kv direct current, negative polarity. The rectifier using tubes mentioned previously[13] can be made small and light enough, with the rectifier, high resistance, and cable end all under potting compound, to permit its practical use at the extremities of the airplane.

The purpose of the high resistance in series with the rectifiers is to hold the corona current down to the noninterfering form at high altitudes.

Although this open design of charging discharger has not been tested, its performance can be estimated from the performance of the enclosed design charger which was used and which is illustrated in Figures 3 and 5. This performance can be represented with the same kind of curves as used in Figures 8, 9, and 10 for the previous static eliminators. This is done in Figure 13, where as before, the dashed curve R represents the untreated airplane, the dotted line S represents the effect of the charging dischargers, and the solid line is the total discharged current.

It is seen that although the curve for the charging dischargers has been drawn roughly similar in shape to that for the untreated airplane or for previous discharges, the displacement of the curve towards and past the zero-charge axis creates a very different situation in which the airplane retains radio reception while the current picked up from the snow rises to a higher order of magnitude. Although details of the curve can be changed with details of design and other factors, this order of magnitude of improvement is to be expected in any case, and consequently deserves to be tested on an adequate airplane.

There is an additional distinguishing feature of this method. It will be noted that the operation of the discharger depends upon the slip stream, and that the amount of current discharged increases with increasing speed of the slip stream. Such is not the case with any previous dischargers. It is for this reason that this kind of system would seem to be essential in any effort to cope with the snow static problem on modern very high speed military aircraft. Snow static on high speed military aircraft is a problem for which the Air Forces have no solution at present.

Although the military forces have a monopoly of the highest speed aircraft on which this new principle of snow static elimination could most strikingly be tested, it is believed that with proper consideration for making all tests comparative, a sufficient flight test can be made by a civilian agency with one of the faster and larger modern transport planes at a smaller cost than that commonly encountered in airline problems of comparable importance.

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Quartz Crystals Grown in Laboratory

Clear, sparkling crystals of real quartz, identical in every way to those produced only by the processes of nature, now are being grown inside bomb-like steel "test tubes" at Bell Telephone Laboratories according to a paper by Ernest Buehler and Alfred C. Walker, presented at a meeting of the International Union of Crystallography at Harvard University, Cambridge, Mass. Recent experiments have been so successful that commercial manufacture of the mineral seems possible for the near future.

From a small seed plate, suspended in a specially constructed bomb and subjected to pressures exceeding 15,000 pounds per square inch and to a temperature of 750 degrees Fahrenheit, a clear crystal more than an inch long may be grown in a month.

The material from which the quartz crystals are grown is a finely powdered form of silica, a common chemical compound which looks something like granulated sugar. This is placed in the bottom of the steel bomb and an aqueous alkaline solution is added. The seed plate, a thin wafer of quartz, is suspended at the top of the bomb; the bomb then is sealed and placed in a furnace. The silica dissolves and rises to the cooler part of the bomb, and is deposited on the seed plate in perfectly regular order until all of it is in the form of a single clear crystal.

Modern Trends in Hydraulic Turbine Design

WILLIAM J. RHEINGANS

THE ART of hydraulic turbine design never stands still but always progresses. In recent years major emphasis has been on the materials of construction and on such features of design as will reduce maintenance work and costly outages in the field.

WELDED PLATE STEEL CONSTRUCTION

There has been a recent increase in the use of plate steel in place of cast steel in the manufacture of hydraulic turbines, due partly to the lower costs of welded structures and the difficulty of obtaining sound castings. The most noteworthy example of this trend has been the fabrication and installation since 1938 of 14 large-size welded-plate-steel spiral casings for turbines operating under various heads from 208 feet to 435 feet. Inlet diameters of the scroll casings ranged from 12 feet to 16 feet with plates varying in thickness from 7/8 inch to $2^1/_{16}$ inches. Four of the casings used riveted field joints, while ten casings were installed with welded field joints, without stress relieving by annealing. Careful control of the welding procedure, inspection, and tests resulted in a complete absence of any weld failures or leakages either during special pressure tests or after 3 to 5 years operation in the field. Figure 1 shows one of two all-welded spiral casings for the 91,500-horsepower 330-foot-(435-foot maximum) head turbines for Fontana power plant. All the joints between the plate steel and the cast steel speed ring were shop welded and annealed. The field joints were welded without annealing but all of these welds were peened and the amount of peening was controlled by extensometers.

There also has been a trend towards fabricated construction of other turbine parts. An interesting example of this is the installation of the five 50,000-horsepower 195-foot-head turbines for the Maraetai plant, Public Works of New Zealand. All of the principal turbine parts are of welded plate steel construction including spiral casing, speed ring, top and bottom covers, guide vane, shifting ring, draft tube liner, and pit liner.

Other recent applications of welded plate steel construction are the 172 buckets being manufactured for the 56,000-horsepower 2,200-foot-head Big Creek *2-A* unit, and the 11,000-horsepower 865-foot-head Kern River units of the Southern California Edison Company. The bucket bowls are die-pressed out of plate steel. The splitters are of forged steel and are welded to the bucket bowl. The lugs are also of plate steel and are welded to the back of the bucket. This type of construction eliminates the difficulties usually encountered with large bucket castings.

Digest of paper **48-191**, "Modern Trends in Hydraulic Turbine Design," recommended by the AIEE power generation committee and approved by the AIEE technical program committee for presentation at the AIEE Pacific general meeting, Spokane, Wash., August 24–27, 1948. Scheduled for publication in AIEE *TRANSACTIONS*, volume 67, 1948.

William J. Rheingans is assistant manager, hydraulic department, Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

USE OF STAINLESS STEEL

Stainless steel is being used to a greater and greater extent for resistance to cavitation and the erosive and corrosive action of silt and chemicals in the water. Solid stainless-steel runners weighing up to 20,000 pounds have been cast and have been used successfully where other materials were subject to considerable erosive and corrosive action in addition to cavitation.

Stainless-steel guide vanes, facing plates, wearing rings, and discharge rings in addition to solid stainless steel runners, indicate a possible solution to the excessive wear and cavitation of high-head Francis turbines which now limits their use.

SELF-LUBRICATING BEARINGS AND CARBON SEAL RINGS

A new design of main bearing and carbon seal ring for vertical-shaft Francis turbines provides a bearing immersed in an oil bath covering about one-third of its vertical length. Properly slanted and shaped oil grooves provide for self-lubrication, thereby eliminating the troubles usually associated with mechanical lubrication.

The carbon ring seal consists of one or more sectionalized carbon rings held against the shaft with garter springs. This type of construction eliminates the constant adjustment required by packing boxes and reduces wear on the shaft.

The increased use of plate steel and stainless steel, and other new features in hydraulic turbines, indicate a desire on the part of the designers to reduce original costs and to eliminate costly maintenance work as much as possible.

Figure 1. All-welded-plate casing

Economics of Long-Distance Energy Transmission

R. E. PIERCE
FELLOW AIEE

E. E. GEORGE
FELLOW AIEE

THE ECONOMIC location of steam-electric generating stations is receiving intensified study, not only because of the tremendously increasing demand for electric energy, but because of changes that have taken place and still are occurring in the relative effect of certain primary controlling factors. These include changes in the relative effects of

1. Location and cost of alternate fuel supplies.
2. Cost of transporting alternate fuels.
3. Cost of transmission of electric energy.

Comparative summaries of the cost of transmission of energy in the form of coal, gas, oil, and electricity have been made. Relative costs of the three fuels near their sources are shown in Figure 1 for the period 1922 to date,

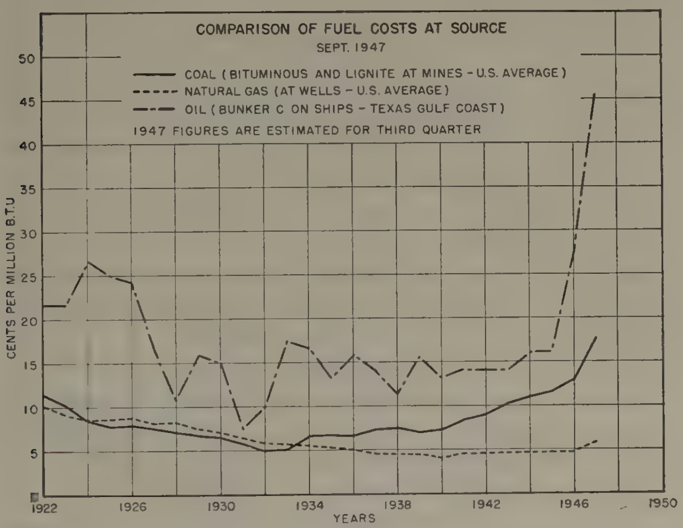

Figure 1. Comparison of fuel costs at source

illustrating the extent to which the relationship between fuel costs has changed within the last few years. Figure 2 shows costs plus transportation. From these data it is apparent that consideration must be given, in the economic choice of steam power plant location, to present day costs of fuel at the nearest sources and present day costs of transmission of the fuels versus the cost of transmitting electricity. The problem is analyzed only under average or typical conditions, but the results give an indication of the need for basic studies in each particular situation and give a fair approximation of the answer for average conditions. It may be concluded that

1. Technical improvements in the art have in large measure offset increases in cost of electric transmission.

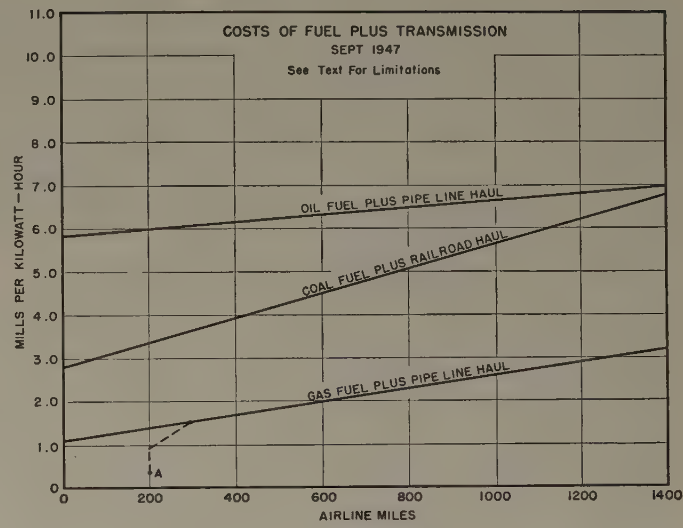

Figure 2. Costs of fuel plus transmission

2. Cost of electric transmission for optimum loads and voltages can be expressed as a linear function of power and distance.
3. Cost of fuel transportation can be expressed as a linear function of energy and distance.
4. Electric transmission at low load factor is competitive with hauling coal by rail for only short distances.
5. Electric transmission at high load factors (base load plants) is competitive with hauling coal by rail for any distance (up to several hundred miles).
6. Electric transmission is generally much more expensive than transporting energy by gas or oil pipe line.
7. The cost of transmitting energy by gas pipe line is several times as high as by oil pipe line.
8. Tanker transportation of oil costs only about half as much as pipe line transportation.
9. The costs of fuel and its transportation to load centers are usually the dominant factors in determining the market value of hydro energy.
10. Coal and gas are no longer competitive, either close to both sources or several hundred miles away. Gas may be carried several hundred miles and still compete with coal near the mine.
11. Fuel oil is now too high for use except for standby service, unless tanker haul is available and other fuel sources are several hundred miles distant.
12. A mouth-of-mine steam plant is economical if the plant load factor approaches base load conditions.
13. If gas or oil is to be used for fuel, a power plant location near the load will almost always be most economical.

It has been rather usual practice to locate plants at adequate natural water supplies and adjacent to fuel sources or transportation, with transmission of the energy electrically to the load. If the transmission of electrical energy produced from fuel involved distances in the order of 200 miles, the economics of this practice was questionable. Even 200 to 300 miles was not too favorable unless the amounts of power to be transmitted were relatively large and competing fuel costs relatively high.

Digest of paper 48-195, recommended by the AIEE transmission and distribution committee and approved by the AIEE technical program committee for presentation at the AIEE Pacific general meeting, Spokane, Wash., August 24–27, 1948. Scheduled for publication in AIEE *TRANSACTIONS*, volume 67, 1948.

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Power From Process Steam

WILLIAM E. ZELLEY
MEMBER AIEE

The constantly increasing demands for power, together with the increasing cost of fuel, have emphasized the desirability of investigating power generation in industrial plants which have need for large quantities of process steam. Careful individual analysis of a plant is required in order that the possibilities may be explored.

WE have just passed through a period of several years that have seen the expenditure of vast quantities of our natural resources, one of the most important of which is fuel. During that time and continuing after the termination of the war, the quantity of electric power required by the industries of the United States has increased by leaps and bounds, and many of the public utility systems found themselves unable to take on additional loads because their plant expansion had not kept pace with the demand increase.

The power available per employee, according to a recent survey, was approximately 6.3 horsepower in 1939; but in 1947, when normally an increase would have been expected, the available power per employee decreased to 4.6 horsepower, a drop of $33^1/_3$ per cent.

At the same time, many of the industrial plants purchasing power from the utility companies were using the products of their fuels inefficiently and, by having a workable agreement with the utility, could generate, at a lower cost, a portion of their power requirement. This would result in several advantages:

1. Lowered cost of power by the efficient use of the plant equipment, for example, the generation of power by means of noncondensing extraction turbines with high pressure steam being reduced to the value required for plant heating and processes.

2. Reduction of the demand being made on the capacity of the public utility system. Consideration must be given to the necessity for repair and maintenance time when the generating units will not be in service. In some cases it may prove practical to do such work during normal nonoperating periods of the plant.

3. Less vulnerability to the possibility of complete loss of power in the event of transmission line faults, by reason of being able to generate a portion of the power requirements within the plant.

This article is not intended to advise any industrial user of power to enter the field of power generation in competition with the established public utility system serving his particular area. The valuable service that has been rendered during the past years and the continued decrease in the cost of electric power to the consumer have demonstrated that the utilities are an important cog in this machine of industrial progress and good living.

There is, however, a field that is being explored at greater detail now than in the years past. One plan that offers a substantial saving in the cost of power for the industrial plant is the use of extraction or topping turbogenerators in industrial plants where a sufficient quantity of relatively low pressure steam is required for general process use and for heating.

A BRIEF REVIEW OF HEAT REQUIREMENTS

It is necessary to add 970 Btu to a pound of water at atmospheric pressure to change its state from a liquid to a steam. When this steam is used for the generation of electricity in the usual manner, the greatest portion of the total heat is lost in condenser cooling water and serves no useful purpose. It is well-known that the higher the pressure and temperature of the steam at the throttle of the turbogenerator, and the lower the pressure at the point of condensation, the greater is the thermal efficiency of the cycle. It is also well-known that as the pressure increases, the total heat does not keep pace with the pressure increase, but reaches a point when further increase of pressure does not result in increased total heat.

The total heat in steam can be increased, however, by superheating. This superheat can be added to steam very effectively, and as the efficiency of heat engines increases with higher temperatures, a marked increase in operating efficiency can be obtained by this addition.

Figure 1 is from a compilation of some published information by several turbine manufacturers referred to a standard condition, showing how the heat required to produce a kilowatt-hour varies with the total heat (pressure and temperature) of the steam, remembering always that the heat of vaporization is lost; therefore, the more heat in the steam, the greater the percentage that can be recovered to do useful work.

It was to reduce this loss of the heat of vaporization that the extraction-type turbogenerator was designed and built. By the use of such a unit the total heat input per kilowatt-hour to the turbine can be reduced, even in relatively small units of from 3,000 to 5,000 kva.

This does not mean that the writer is advocating that every plant install a new power generating unit consisting of a high pressure and temperature boiler, a turbogenerator

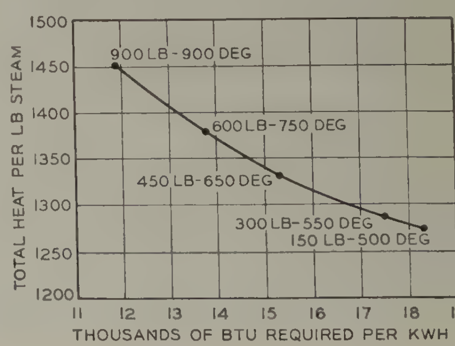

Figure 1. Heat required to produce a kilowatt-hour of electric power

Essential substance of a conference paper, "Economics of Process Steam Generation," presented at the AIEE winter general meeting, Pittsburgh, Pa., January 26–30, 1948.

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of the extraction type, and the other necessary equipment; but does mean that engineers in this line of professional endeavor should not hastily commit themselves to a definite course of action until a thorough survey has been made of the situation as it exists in the particular industrial plants that they may be required to study.

APPROACH TO THE PROBLEM

All the factors that have a bearing on the subject should be included in such a survey. The facilities for steam generation must be given careful consideration, as in most plants some steam is required at all times. When that equipment is in need of replacement, it is important that the possibility of generating power by the use of noncondensing, noncondensing extraction, or condensing extraction turbines be investigated. This investigation, when carefully carried out, will show whether or not it is advisable to consider the installation of such turbogenerator equipment, and the proper size and type to be used.

The problem of whether a plant shall generate any or all of its electric power can not be decided until these steps have been taken, and a working agreement made with the utility, in the event a partial generation program has been decided upon.

The selection of the proper generating and control equipment will be controlled largely by the decision as to the type of operation; in the case of complete generation, the lines and switchgear need be only of sufficient capacity to carry the present loads, plus whatever may be allowed for future expansion, but when parallel operation with a utility system is planned, then all the electric equipment must be selected to withstand the heavy short-circuit currents that may be present as a result of a fault being fed by not only the plant generating capacity but by the available current from the utility system.

Only when all these problems have been solved carefully can it be possible to arrive at an accurate estimate of the cost of the installation, and thereby ascertain if it is economically feasible to generate power in the plant. Many engineers for years have hoped for some simple formula that would answer this question, but up to this time the only way in which the question of power generation can be answered in a satisfactory manner is by making a very complete survey of the conditions that exist and as they may exist under changed circumstances.

A PRACTICAL STUDY

Recently a study was made of a plant in New Jersey that had been generating steam for industrial power and heating at 150 pounds per square inch gauge with little or no superheating of the steam. The old steam generating equipment was very inefficient and beyond economical repair, and it soon became apparent that complete replacement of the steam generating equipment was necessary. Accordingly, the steam requirements of the plant were studied carefully, and the size and number of new boilers was determined.

The final selection of operating pressure and temperature was not made until a thorough survey of the electric power requirements had been completed, and as that survey

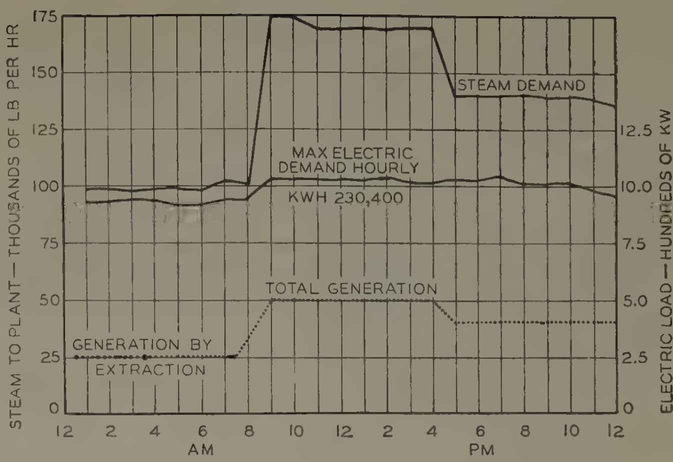


Figure 2. Demand for 150-pound steam and electric power in an industrial plant

indicated that a large portion of the electric power could be generated economically by the use of an extraction turbogenerator, it was decided that this plant could be served most economically by the installation of boilers capable of producing the required amount of steam at 650 pounds per square inch, superheated to a total temperature of 750 degrees Fahrenheit.

In order to make a complete survey of the possibilities of generating power in this plant, a careful compilation of the electric loads for the past several years was made, and a day-by-day plotting of steam demands at low pressure (150 pounds) was made and compared with the electric demands. From these compilations it was possible to determine the amount of power that could be generated by reducing the pressure and temperature of the steam required by the plant from 650 pounds and 750 degrees to the values required by the plant.

This survey indicated that by the installation of a 5,000-kw noncondensing turbogenerator, it was possible to generate 30 per cent of the power required by the plant during the year, with some variation between the summer and winter seasons. By the use of a condensing single automatic extraction unit, this percentage of power to be generated could be increased to approximately 50 per cent. This was possible with no increase in operating labor, and even though the fuel rate per kilowatt-hour is increased, the cost per kilowatt-hour is still well below that of purchased power.

In the process of determining the best size of the generating unit, it was found advisable to study the problem by actually calculating the power that could be generated under all conditions by the use of several sizes of generators. The sizes considered in the study were 3,000, 4,000, 5,000, and 6,000 kw and the 5,000-kw unit was selected as being the one that would allow the maximum return on the investment.

In order to show graphically the demand for steam at 150 pounds and electric power demand during the 24-hour day, Figure 2 has been prepared. The electric demand at all times is of a greater percentage of maximum than is the steam demand which gives a very favorable condition for the operation of the extraction type of turbogenerator,

as it always will be possible to consume all the power that may be generated by reducing the pressure and temperature of the steam required by the plant from 650 pounds and 750 degrees to 150 pounds and 390 degrees required for plant use.

The steam requirements show some variation between the winter and summer conditions, and this variation is shown in Figure 3. It is apparent that under certain conditions it will not be possible at all times to pass the total steam required through the turbine so a pressure reducing and desuperheating station has been installed to supply the low-pressure steam required. The schematic arrangement of the steam piping is shown on Figure 4, which shows the relative position of each of the items of equipment mentioned, and the quantity of steam to be passed through each path under normal conditions.

Because of some extreme operating conditions and more or less indefinite plans for the future of some parts of this plant, it was decided that the installation of a condensing single automatic extraction unit would be of great value in enabling the plant operating personnel to carry the most economical loading of the generating equipment. It is expected that the turbogenerator will operate at minimum exhaust flow for the greater portion of the time and that the condenser will be required to condense only the turbine exhaust end cooling steam.

The control of the load to be carried by the generator has been given careful consideration, and the steam flow to the turbine will be controlled by a dual system, by load on the generator and the pressure at the extraction point. In other words, should the operator be required to carry a continuous load on the generator even in the face of a fluctuating plant steam demand, the speed controlling element will pass sufficient steam through the throttle to maintain the turbine speed, and the extraction pressure controlling element will vary the extraction mechanism as required to maintain the extraction pressure. Any increase of extraction pressure due to lessening of the plant steam demand will automatically reduce the throttle opening as well as increase the openings in the ports leading from the extraction point to the low pressure stages allowing more steam to pass to the condenser, resulting in a unit capable of carrying a constant load without serious control problems arising from the variations in plant steam demand.

EVALUATION OF COSTS

Information furnished by several turbogenerator manufacturers shows that power can be generated by the single

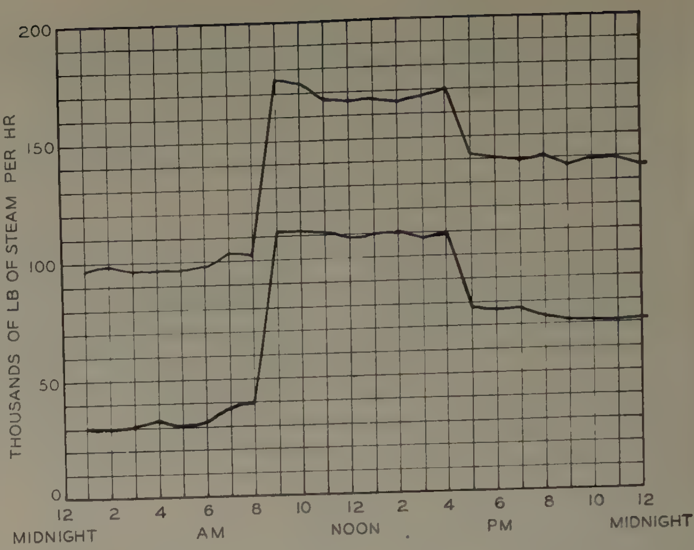


Figure 3. Variations in steam requirements between winter (upper curve) and summer (lower curve) operating load

extraction type turbine with 600-pound 750-degree total temperature steam at throttle, extraction at 150 pounds and 510 degrees, and with minimum exhaust flow, with a rate of 5,000 Btu per kilowatt-hour or less, an over-all efficiency of the turbine heat cycle of 71.5 per cent. With the use of modern steam producing units that operate at a monthly efficiency of 85 per cent the net over-all thermal efficiency of such generation is 60.7 per cent. With fuel costs, in the area considered in the range of $.30 per million Btu, the fuel cost to generate power is $.0017 per kilowatt-hour.

For the past several years the electric power used in the plant studied has been purchased from the public utility company in the area at the published "wholesale power and lighting service" rate; a summation of that rate is shown in Table I, from which it is seen that the lower the demand is kept and the higher the load factor maintained, the lower the net cost of power.

The plant has operated during the past year with a maximum demand of 11,000 kw and a monthly consumption of 5,250,000 kilowatt-hours with the plant operating on a 5-day 3-shift basis, the load on nonoperating days being only about 1,000 kw. This means an average of 21 operating days per month and 9 nonoperating days, and shows an over-all load factor of nearly 64 per cent, but if the nonoperating days are not considered then consumption is 5,034,000 kilowatt-hours with 504 hours of operation, a load factor of nearly 91 per cent.

Table I. Example of the Application of Wholesale Power and Lighting Rate

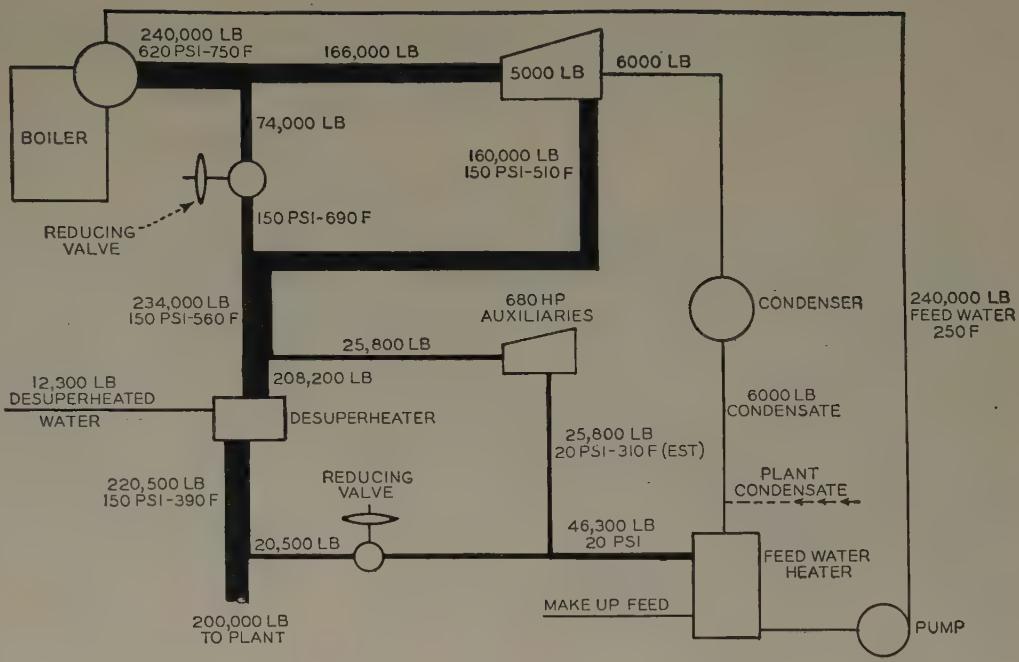
Demand or kilowatt charge:	
11,000 kw at $1.10 per kilowatt+$410	$12,510.00
Energy or kilowatt-hour charge:	
5,000,000 kilowatt-hours at $0.005+$2,200	27,200.00
Total	39,710.00
Less discount of 10 per cent not exceeding $3,000 per month	3,000.00
	36,710.00
Fuel adjustment charge at $0.00123 per kilowatt-hour	6,150.00
Net cost per month	$42,860.00
Average cost per kilowatt-hour	$ 0.008572

Table II. Example of the Application of Auxiliary or Breakdown Rate

Contract capacity charge, 11,000 kw at $0.60 per kilowatt plus $135	$ 6,735.00
Demand charge, 11,000 kw at $0.60 per kilowatt plus $135	6,735.00
Energy charge, 5,000,000 kilowatt-hour at $0.005 per kilowatt plus $2,215	27,215.00
Total	40,685.00
Less discount, 10 per cent not exceeding $3,000 per month	3,000.00
	37,685.00
Fuel adjustment charge at $0.00123 per kilowatt	6,150.00
Net cost per month	$43,835.00
Average cost per kilowatt-hour	$ 0.008767

Figure 4. Steam flow balance

PSI=pounds per square inch



In addition to the rate shown in Table I, the utility company also made a fuel adjustment charge per kilowatt-hour whenever fuel costs exceeded 22.5 cents per million Btu. This fuel adjustment charge has ranged from $0.0009 to 0.00153 per kilowatt-hour for the past year with an average of 0.00123.

This utility company also has an auxiliary or breakdown rate which it applies to customers who generate all or part of their electric power requirements, and a summary of the application of that rate is shown in Table II. This rate makes a charge per kilowatt demand per month for the contracted load with an additional charge per kilowatt demand actually made. This charge, together with the energy and fuel adjustment charges, makes up the total power cost.

As previously shown, the average cost of power at this plant was $0.0087 per kilowatt-hour, which represents an annual power cost of $543,834 for 62,400,000 kilowatt-hours, the estimated annual consumption.

By the installation of an extraction turbogenerator, it is possible to generate a large portion of this load at a fuel cost of $0.0017 per kilowatt-hour. The monthly cost of power in this case even when contract demand is set at the maximum is as follows:

Contract demand charge, 11,000 kw		$ 6,735.00
Actual demand charge, 7,000 kw		4,335.00
Energy charge, 2,500,000 kilowatt-hours at $0.005+ $2,215		14,715.00
Total		25,785.00
Less 10 per cent discount		2,578.50
		$ 23,206.50
Average fuel adjustment charge, 2,500,000 kilowatt-hours at $0.00123		3,075.00
Total purchased power charge		$ 26,281.50
Generation		
1,750,000 kilowatt-hours at 0.0017 (fuel cost)	$2,975	
1,000,000 kilowatt-hours at 0.005 (fuel cost)	$5,000	
	$7,975	
Total per month		$ 34,256.50
Total per year		407,178.00
Differential		$ 136,656.00

FINAL SELECTION

From this total differential in power cost per year there must be subtracted $30,000 per year, the estimated cost of operating labor and maintenance of the generating equipment, leaving a balance of $106,656 per year to cover the fixed charges, an annual return equal to approximately 25 per cent of the installation cost. The generating equipment of the plant discussed will consist of one 5,000-kw 3-phase 60-cycle 2,400/4,160-volt generator directly connected to a 650-pound 750-degrees-total-temperature condensing extraction turbine arranged for automatic control of extraction pressure at 150 pounds, and a 3,000-square-foot surface condenser.

The electric equipment will be of the metal enclosed type, with air circuit breakers having an interrupting capacity of 250,000 kva at 4,160 volts and will be connected to the secondary distribution system of the plant as shown in Figure 5.

The unit will carry full load during the normal operating shifts of the plant in parallel with the public utility system and during nonoperating periods of the plant will operate in parallel with the utility, carry all the plant load, or be shut down as may be determined by need at those times.

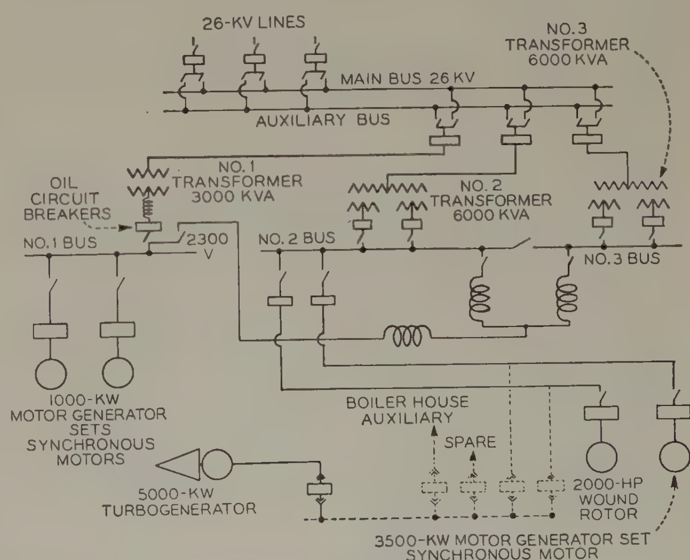


Figure 5. Line diagram showing the connections of the electric equipment

Reading Makes a Full Man*

D. H. ERICKSON
ASSOCIATE AIEE

Formal engineering education tends to specialize the engineer. Good reading is an excellent way to make him a well-rounded individual.

THE PROCESSES by which the engineer acquires an education are primarily through directed training, such as the formal detailed curricula of grade school, high school, college, and perhaps company training courses, and secondarily through informal training resulting from personal contacts with older, more experienced men, and through the reading of literature in the form of books, magazines, and newspapers.

The result of the formal education is to semispecialize the engineer in a particular field of endeavor, and the result of the informal training is to complete the specialization. The latter is generally because his contacts are with men like himself, engaged in the same type of work, and because his books and magazines tend to advise him further regarding certain phases of the work he is engaged in.

In the end, unless our engineer continually transfers from job to job, and from one field of work to another, he becomes narrower in his outlook. More of a type that has a purely mechanistic outlook on life, with a sublime disregard for the results of his bridges, long-distance telephone lines, or the now ubiquitous atomic power, on the lives of his fellow travelers.

We are many of us familiar with the efforts of the more progressive educators to send the engineer graduate out into the world with a broader outlook on life. They propose to do this by several methods, among which are the 5-year course instead of the present four, and the addition to the course of a number of the social sciences without which they believe the engineer cannot appreciate his station in our economic and cultural system, nor can he contribute in his fullest capacity toward the advancement of society and the health, happiness, and general well-being of the human race.

This improvement in education, provided it becomes universal in all schools (and there is good reason to believe some colleges still are going to remain trade schools), will be very fine for our sons, but what about us who are 1, 10, or 30 years out of school? Some of us are getting narrower in our outlook every year. Many newspapers are ridiculously partisan in their presentation—many of our fellow-workers are biased sadly along religious and racial lines. Few magazines write articles that are not slanted in viewpoint; all of them catering to the mass of semieducated Americans who form the backbone of the nation, and who look to others for leadership.

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* From Francis Bacon.

The engineer thus has arrived at the problem of obtaining a further education in the humanities. A problem that is our duty as fathers, citizens, and more especially engineers, to solve. The solution, reading a better and higher type of literature, comes easier than does that of an intricate calculus problem. We must read ourselves to a knowledge of living and of human relationships that only the great thinkers of the past and present can give us.

For a starter let us try John Macy's "The Story of the World's Literature." Then, as a sample of some of the best, read the following:

Adams, Henry	"The Education of Henry Adams"
Augustine	"Confessions"
Beard, C. A.	"The Rise of American Civilization"
Brooks, Van Wyck	"The Flowering of New England"
Cervantes, M.	"Don Quixote"
Descartes, Rene	"Discourse on Method"
Durant, W.	"The Story of Philosophy"
Emerson, R. W.	"Essays"
Fielding, H.	"Tom Jones"
Franklin, B.	"Autobiography"
Frazer, J. G.	"The Golden Bough"
Goethe, W.	"Faust"
James, W.	"The Principles of Psychology"
Mann, T.	"The Magic Mountain"
Montaigne	"Essays"
Paine, Thomas	"The Rights of Man"
Plato	"Dialogues"
Reade, C.	"Cloister and the Hearth"
Rousseau, J. J.	"Social Contract"
Shakespeare, W.	"Works"
Swift, J.	"Gulliver's Travels"
Thoreau, H.	"Walden"
Tolstoy, L.	"War and Peace"
Voltaire	"Candide"
Wells, H. G.	"Outline of History"
Whitman, W.	"Leaves of Grass"

A wonderful thing for you (and your children to grow up with) is a home library containing not only the books previously listed, but perhaps a 100 or more of the "greater" books. Then you will be able to read at your leisure, when you are most able to grasp the thoughts of the writer, and not under the constant threat of a fine for an overdue library book. Most of the classics and semiclassics are put out in excellent reprint editions, and if you have the time for browsing, a second-hand book store is a treasure of printed wealth for very nominal prices.

Which books to select is not a problem as there are numerous lists put out describing the "ten best books," "100 greatest —," and so forth. Your local librarian will be glad to help you on this.

Bulwer said "In science, read, by preference, the newest works; in literature the oldest. The classic literature is always modern. New books revive and redecorate old ideas; old books suggest and invigorate new ideas."

Irrigation Pumping With Grand Coulee Power

S. M. DENTON
ASSOCIATE AIEE

THE COLUMBIA BASIN PROJECT includes the Grand Coulee dam and power plant, the Grand Coulee pumping plant, and about one million acres of irrigable land for which irrigation water will be made available. The power plant will comprise an ultimate installation of 18 main generating units and 3 station service generating units which will be capable of developing 2,300,000 kw.

As the land to be irrigated lies on a plateau several hundred feet above the level of Franklin D. Roosevelt Lake, the storage reservoir behind Grand Coulee dam, water is to be pumped from this reservoir to another, smaller reservoir formed by damming the two ends of the famous Grand Coulee. It will be necessary to raise about 16,000 cubic feet of water per second through a lift ranging up to 365 feet.

The Grand Coulee power plant is divided into two powerhouses, one located at each end of the dam. The pumping plant will be located just upstream of the west abutment of the Grand Coulee dam and will contain an initial installation of six pumping units. The operation of ten pumping units will be required to meet the maximum pumping requirements under the fully developed plan.

Pumps of unprecedented size are being built for this installation. Each pump will be rated 1,350 cubic feet per second at a pumping head of 310 feet. The pumps will operate through a pumping lift range of 270 feet to 365 feet. The greatest portion of the pumping will be through a lift of 270 feet when the Columbia River storage reservoir is full, under which condition the pumps will deliver in excess of 1,600 cubic feet per second. Each pump will weigh approximately 250 tons and its rotating parts 60 tons. Each pump discharge pipe will be 12 feet in diameter and about 700 feet in length.

The motors for driving the pumps will be of the synchronous type each rated 65,000 horsepower at 200 rpm, and they will operate at generator voltage and unity power factor. The motors will be of the vertical type having the thrust bearing located above the rotor supporting the rotating parts of the motor and pump. The combined weight of each pump runner and shaft, together with the unbalanced hydraulic thrust will be about 125 tons, and the weight of the rotating parts of the motor will be about 150 tons. The motors are being designed to withstand stresses resulting from operation at runaway speed of 295 rpm. The thrust bearings will be equipped with means for establishing an oil film during the starting cycle until sufficient speed is attained to insure a full thickness of oil film. Each motor will have a separate motor-generator exciter set to furnish excitation during the starting operation. An enclosed cooling system is furnished for each motor.

The motors will have sufficient torque for the breakaway of the pumps and motors and to accelerate the pump up to normal speed with water inside the pump casing and free discharge. The pull-out torque will be not less than 150 per cent of full load torque.

The size of the pumps and motors presented a new field of starting problems. The use of 60-cycle reduced-voltage starting was discarded in favor of a scheme whereby the motors will be started by a single generating unit operating at less than normal voltage and frequency. During normal operation two motor-driven pumps will be connected to one generating unit through a generator voltage bus about 1,200 feet long. Either of two methods may be used in starting these motors:

1. The synchronous method in which motors are direct connected to the generators at standstill and brought up to normal speed in synchronism.

2. Starting as an induction motor with generating units operating at reduced speed when the motors are pulled into step.

The synchronous method of starting requires that the generator and its associated pump motor or motors be connected at standstill. Excitation will be applied to both the generator and pump motor fields simultaneously with the opening of the turbine gates. The generating unit and the pumping unit or units will be accelerated to normal 60-cycle speed by operation of the governor gate control causing the gates to open where they will be placed under the control of the hydraulic governor.

Induction motor starting will be accomplished by connecting the pump motor to the generating unit which is operating at reduced speed without field and with the turbine gates closed. Excitation will be applied to the generator field causing the motors to start as induction motors and accelerate and pull into step with the generators. With the turbine gates closed, the generating unit will decelerate while the motors are accelerating which will ease the pulling-into-step requirements of the motor. After the motors and generators are synchronized, the turbine gates will be opened to accelerate the generator and motor or motors up to normal speed where they will be placed under control of the hydraulic governor.

The pumping power requirement can be met largely with off-peak power developed at the Grand Coulee power plant. Generators assigned pumping will be available for commercial service during the nonirrigation periods and also may be used to meet daily peak demands even at the height of the irrigating season. The general plan for pump operation will be integrated in so far as possible with the commercial power requirements so that little or no interference will result in the power demands being met.

Digest of paper **48-192**, "Irrigation Pumping With Grand Coulee Power," recommended by the AIEE power generation committee and approved by the AIEE technical program committee for presentation at the AIEE Pacific general meeting, Spokane, Wash., August 24–27, 1948. Scheduled for publication in AIEE *TRANSACTIONS*, volume 67, 1948.

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Nuclear Reactors for Power Generation

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This last article of a series developed by the AIEE nucleonics committee is concerned mainly with a discussion of the various technical and engineering problems which arise in the process of transferring the energy of the fission reaction into heat in the steam or gas to be used in the heat engine. The purpose of these articles has been to furnish the reader with an over-all picture of recent developments in nucleonics and allied fields. The entire series* is scheduled for early publication in pamphlet form.

IN the popular mind, and usually in the engineering mind, reference to power generation by nuclear reactors immediately suggests electric power generation. It takes for granted that the power will be available for electric distribution. From an engineering viewpoint it makes little difference whether the output is to be electric power or mechanical power, for the only practical conversion processes now envisaged involve a transformation of the kinetic energy released (or created) by the nuclear fission into heat energy and then, by a heat engine, into mechanical energy with a final transformation, if need be, into electric energy. The possibility of making these transformations has been well demonstrated even though, in some instances, the efficiency has been low. No one yet has been able to devise a direct transformation from the fission reaction to electric power.

No new problems are involved in the transformation from mechanical to electric power. There are no new problems of major magnitude in the transformation of the heat energy into mechanical power, once the heat has been transferred to a suitable thermodynamic medium. There are many difficult technical and engineering problems in transferring the energy of the fission reaction into heat in the steam or gas to be used in the heat engine. This article will be devoted largely to a discussion of these problems.

Carnot's principle teaches that there is an upper limit to the efficiency that may be attained by any simple heat engine and that this may be expressed as

$$\eta=(T_1-T_2)/T_1$$

where T_1 and T_2 are the initial (or higher) and final (or lower) temperatures of the working fluid. In any practical heat engine the actual efficiency will be lower than this ideal because of stray heat and mechanical losses. Under favorable conditions, with cooling water for condensers available, T_2 may be in the order of 535 degrees Rankine (75 degrees Fahrenheit); with air cooling as with some gas turbines it may be near 750 degrees Rankine (290 degrees Fahrenheit). The urge to go to higher initial temperatures is therefore evident, and considering only the heat engine T_1 probably would approach 1,000 degrees Fahrenheit for steam turbines, and 1,300 degrees Fahrenheit or, possibly, 1,500 degrees Fahrenheit for gas turbines.

It becomes clear, then, that for practical power generation the heat must be available at a turbine or other heat engine at a temperature of at least 300 degrees Fahrenheit. Several studies that have been made have been based on values in the range 750 degrees Fahrenheit to 1,200 degrees Fahrenheit.

REACTOR REQUIREMENTS

We return now to the reactor. Professor Friedman[1] has outlined the conditions essential to the operation of a well-controlled reactor. In general rather than in precise terms, the more important of these may be stated as

1. The quantity of fissionable materials must exceed a "critical" value.
2. The volume-surface ratio must exceed a minimum limit.
3. The concentration of neutron absorbing materials within the reactor must not exceed definite limits.

It will be helpful to examine these requirements one by one as they relate to the problems of power generation.

The first means that the total quantity of fissionable materials must be maintained at all times within definite limits. If the amount is too small the chain reaction will not start (or will die out); if it is too large control becomes difficult or impossible. Thus means must be provided for replenishing the fissionable material from time to time, or continuously as it is used up.

The second means that the "density" of the fissionable materials must be kept within limits, which will depend on other factors such as the configuration or structural arrangement. The designer has some freedom of choice and, to the extent that neutron reflectors can be used, greater freedom of choice, but at best it is less than that available to the designer of fuel burning steam generators.

The third means that great care must be taken in the design of reactors to avoid the use of materials having high specific absorption for neutrons and to limit the quantities of all other nonfissionable materials, for all are neutron absorbers in some degree. It means that arrangements must be provided for the regular removal of fission products for these are neutron absorbers. It means that care must

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* Previously published articles in this series are: "The Atom and Its Nucleus," J. J. Smith (*EE, Dec '47, pp 1165–75*); "The Relation Between Energy and Mass," Frederick Seitz, Jr. (*EE, Jan '48, pp 125–34*); "Nuclear Engineering," E. U. Condon (*EE, Mar '48, pp 229–32*); "Detection and Measurement of Nuclear Radiation," G. Wesley Dunlap (*EE, Apr '48, pp 325–32*); "The Separation of Isotopes," G. Wesley Dunlap, R. M. Lichtenstein (*EE, May '48, pp 469–74*); "Cascades Used in Isotope Separation," Harold C. Urey (*EE, Jun '48, pp 581–6*); "Nuclear Reactors," F. L. Friedman (*EE, Jul '48, pp 685–93*); "High-Energy Particle Accelerators," J. R. Woodyard (*EE, Aug '48, pp 759–67*); "Physical and Medical Aspects of Radiation Hazards and Protection," L. L. German, H. M. Rozendaal (*EE, Sep '48, pp 884–90*).

be taken to avoid boiling liquids within the reactor, for the liquid and the vapor generally will have a different absorption coefficient for neutrons.

A brief consideration of these three basic requirements leads to a number of others that are of an engineering nature. To list a few:

1. The control system must be sensitive with rapid response and yet designed to give stability.

2. The materials used in the active zone of the reactor must not undergo significant changes in their essential characteristics when subjected to intense radiation.

3. The provisions for removal of heat from the active zone must insure that "hot spot" temperatures do not exceed those which the materials can withstand.

Developing these a little more, we find that the first requires that the control system be sensitive first to the neutron flex density in the reactor, and then that it must recognize as well the requirements of the power load. Moreover the relative importance of the different factors is greatly different from that prevailing in fuel burning power equipment. An entirely new sense of values must be developed, first theoretically and then on the basis of experience.

While engineers have become accustomed to such concepts as fatigue and creep and recognize the problems of corrosion, the introduction of nuclear reactors brings in quite a new factor. Under the intense radioactive bombardment by all types of nuclear particles that occurs in the active zone of a reactor, few engineering materials will be immune to change. Many alloys—and few engineering materials are not alloys—depend for their desirable properties on relatively small amounts of the alloying element. A transformation of a small fraction of the carbon content of steel may be significant; a small change in the silicon content of duraluminum alloy may be significant, and so on through almost the entire list. Even the list of possible heat-transfer materials is much shortened when these factors are considered. The field is so new and so extensive that scarcely more than a start has been made in the exploration of it.

The problem of heat transfer within the reactor, or that of developing a means for transferring the heat from the active zone where the fission takes place to the working fluid of a heat engine, has many conflicting factors. The importance of the highest practical temperature at the heat engine has been pointed out. The limitations on the dimensions of the reactor point to small size and high heat flux densities. The limitations on low neutron absorption and stability under radiation preclude the use of many materials having superior heat conductivity. High heat flux densities and low specific heat or thermal conductivity together mean large temperature differences and these, with the desire to attain high output temperatures, mean much higher temperatures within the reactor.

Another group of conditions includes the following:

1. Adequate shielding must be provided for the protection of personnel and equipment against radiation.

2. Either the heat transfer medium must not become radioactive or means must be provided for keeping it separate from the thermodynamic fluid used in the heat engine.

The first of these has been mentioned so often in both popular and technical literature that it scarcely needs comment. Basically it involves only providing a shield of sufficient mass to absorb the radiations or attenuate them to tolerable levels. Practically, it involves a number of difficult problems such as how to provide the necessary access doors and openings; how to avoid structural change and deterioration. And, if ship propulsion or similar applications are being considered, there are the problems of bulk and weight.

The second is of vital concern in the selection of the heat transfer medium and the method of its use.

Before considering some specific power plant arrangements, it may be helpful to regroup some of the peculiar requirements, and particularly those relating to the reactor.

Structural materials (this is taken to include all materials other than the active materials in the pile) should have low specific absorption for neutrons, high strength at elevated temperatures, stability under intense radiation, high thermal conductivity, and good resistance to corrosion.

Heat transfer fluids (these may include liquids, gases, molten metals) should have low specific absorption for neutrons, stability under intense radiation, thermal stability, good heat transfer characteristics, and should not be corrosive.

Metals suggest themselves at once as the principal structural materials, although ceramics offer some interesting possibilities. Of the metals, low alloy steels seem to be excluded on several bases: high neutron absorption, low strength at elevated temperature, questionable stability under radiation. Aluminum, although used in the reactors at Hanford Engineer Works where the temperatures are quite low, seems clearly out of the picture for power reactors because of low strength at high temperatures. Some of the stainless irons such as "18-8" stabilized austenitic have possibilities although not wholly desirable on the basis of either neutron absorption or thermal conductivity. The examination might be extended through the whole list of metals commonly used in engineering and none would be found not open to major objections. This suggests examining some of the higher melting point metals that have not been used for engineering purposes—beryllium, titanium, molybdenum, tantalum, tungsten—to name a few. The metallurgy of these metals has not been developed sufficiently to permit drawing conclusions at this time. It is certain that any of them would be costly, if not prohibitively so. The physical properties of these metals when fabricated in sizes suitable for power plant use are not well known. At best, these materials should be classed as "interesting possibilities."

Ceramics have been suggested, but it would be misleading to consider them as direct substitutes for metals because their interesting and valuable properties can be realized only when the basic machine design is developed with their use in mind. This, in turn, requires development work in new fields of engineering and extensive detailed study and analysis.

An evaluation of heat transfer fluids presents a complex and difficult problem because of the many factors that are involved. One interesting approach has been made by Gilliland.[2] Taking into account the various physical prop-

erties such as specific heat, thermal conductivity, density, viscosity, he has developed two sets of parameters which give a measure of the relative merits of different coolants when taking into account the power required to circulate the fluid. He calculated the values of these parameters for 21 gases and vapors and for 15 liquids and molten metals. A study of these parameters and of data on the neutron capture cross sections lead to the selection of four media for further study. These are helium, water, molten cadmium, and molten lead. To these might be added air.

POWER PLANT DESIGN

With this background, some attention now may be directed toward exploring possible nuclear power plant arrangements.

Of the various heat transfer media only two seem to offer enough possibility of meeting the requirements set by the reactor and also to be usable directly in a heat engine. These are air and helium. Both could be used in a gas turbine, but it is noted immediately that air would be radioactive and both might become contaminated with radioactive fission products. Consequently it seems almost mandatory to provide for a heat exchanger which will serve to isolate the radioactivity and keep it from the turbine.

Once this has been done, all the media come on a common basis as requiring a heat exchanger or steam generator, inasmuch as neither water, molton cadmium, or molten lead can be used directly in a heat engine.

For the heat engine, a steam cycle offers by far the greatest degree of flexibility as the upper temperature may be almost anywhere in the range 250 degrees Fahrenheit to 1,050 degrees Fahrenheit with the possibility of even higher values. The range of upper or initial temperatures for gas turbines is much more limited—say, from 950 degrees Fahrenheit to 1,500 degrees Fahrenheit, on the basis of present-day engineering developments. As explained before, the higher temperatures offer attraction in the way of improved conversion efficiency, but they also lead to serious difficulties in the design of the reactor and it probably will be many years before these can be overcome sufficiently to permit utilizing the full possibilities of the gas turbine.

The power plant design thus has been narrowed down to a reactor transferring heat to a fluid heat transfer medium which is circulated through a steam generator to produce steam which is utilized in a turbine driving an electric generator. The turbine and generator can be quite conventional and will require no further attention. The steam generator presents some new, but not unique, design problems. In particular more than usual care will be needed to develop a construction which will be free from leakage in order to insure against contamination of the steam by radioactive materials. It will be necessary, too, to devise means for cleaning the water tubes from time to time without dangerously exposing the personnel to radiation, for it must be assumed that water contamination cannot be avoided entirely.

The difficult, and very new, problems come in the reactor design, some of which will be discussed in the following.

As a starting point for and engineering analysis, it is convenient to take the Daniels pile as used at Hanford Engineer Works and described by Smyth.[3] In this pile the uranium is encased in close fitting aluminum tubes which then are inserted into tubes of slightly larger diameter disposed in the carbon moderator. The cooling water is circulated through the annular spaces between the tubes. As these piles were designed for plutonium production and not for power generation, the temperatures in the cooling water were kept low.

At first thought it might seem an easy step merely to reduce the flow rate for the water until the temperature rose to the boiling point and steam was generated. A further flow reduction could result in delivering superheated steam. There is however an immediate and major objection. It arises from the fact that, particularly at low pressures, the density of steam is much less than of water and consequently the neutron absorption coefficient will be correspondingly less. This, in turn, will cause disturbances in the nuclear reactions in the pile, and, as is evident from Friedman's discussion[1], these may become so violent as to lead to instability. If the pressure were increased to the critical value (3,206 pounds per square inch absolute) this trouble would be avoided, but other troubles would be introduced through the need for far heavier tube walls to withstand the higher pressures. Additionally, the higher steam temperature (705 degrees Fahrenheit) would exceed the safe working temperature of aluminum. The introduction of more structural metal into the reactor, as would be necessary at the higher pressure would have to be examined critically. Likewise the total amount of heat transfer fluid within the reactor, for both have an adverse effect on the neutron absorption and the performance of the reactor.

A discussion of even a few of the many alternatives that have been suggested would extend beyond the scope of the present article. Enough has been said to show that the solution of the heat transfer problem is, at best, complex and that it will require much detailed information not now available. More particularly information is required on heat transfer between molten metals and solid surfaces, especially at high heat flux densities.

ADDITIONAL PROBLEMS

If we can assume that a tentative solution has been found to the heat transfer problem by itself, then we may pass on to several others.

Some means must be devised to permit removing fission products and replenishing the supply of fissionable materials. As the range is not large between the lower limit of density of fissionables necessary to maintain the chain reaction and the higher limit of density when control becomes difficult, the maintenance of satisfactory operating conditions requires an approach to a continuous process. If we continue to refer to the Hanford-type piles, this means the removal of one bar of uranium in its aluminum case and its replacement by another. The bar that has been removed then is sent to the chemical reprocessing plant where the fission products may be extracted and the fissionable material is recovered for reuse. Means for accomplishing this have been developed at Hanford, but few would argue that they are not susceptible of great improvement.

A continuous process of some type, rather than a batch process, would have many advantages. As the continuous

fuel feeding of a stoker or a powdered coal burner has replaced intermittent hand firing, and as continuous ash or slag removal has replaced intermittent grate cleaning in coal-fired boilers, so continuous feeding and purging may be expected to be developed eventually for reactors. Just how this can be done is not now clear, for the difficulties are not alone those of a mechanism to handle the radioactive materials, but even more those of designing a reactor which lends itself to such processes.

The need for adequate shielding has been mentioned. This is not peculiar to reactors used for power generation and experience being gained in the design of laboratory reactors should provide most of the needed information.

The problem of controlling a reactor so as to maintain some desired level of activity has been well discussed by Friedman.[1] For a power unit, however, where the usual requirement is to meet some power output demand, the problem is considerably more complex. In fact, it may be so great that it will be necessary for the first installations to be operated under conditions that will permit disposing of whatever power the unit may tend to generate at the time by feeding the power into a system having other generating capacity which can absorb the variations.

There are many other details that will need attention before a practical power generating unit can be built. Important pieces of auxiliary equipment will have to be modified extensively or developed. Pumps that circulate the heat transfer fluid will need to be immune to damage by radioactivity of the fluid, and the construction must be such that when the inevitable repair or replacement becomes necessary the work can be done safely by the use of special tools and devices. And so on through a long list of apparatus.

The discussion up to this point has considered the more general problems for which some solution must be found before a nuclear power plant of engineering significance can be built. If we can judge by the experience in other fields, it is not to be expected that the first units—the pilot plants units—will show great similarity with units that may be built after 10 or 15 years of experience, of trial and error.

Nonetheless the broad general outlines are, perhaps, now sufficiently clear so that it may not be venturing too far into the realms of fantasy and wishful thinking to look at some of the economic factors that are involved. In doing so it must be kept in mind that there are special applications, chiefly military and naval, when considerations of expediency in particular values outweigh economic considerations. But in general nuclear power will not become widely useful unless it can be developed to a point where it can justify itself on a cost basis.

It will help the analysis to take a conventional fuel-burning steam turbine power station as a starting point and note the points of similarity and the differences.

No important change is required in the turbine-generator unit with its condenser, nor in the associated electric switchgear.

The steam generator will differ in several details from a fuel burning unit. If the heat transfer fluid is a gas, the unit may have many of the characteristics of a waste heat boiler; if the heat transfer fluid is a liquid or molten metal it will take on quite new characteristics. In either case the heat transfer will be predominately by conduction and convection and almost not at all by radiation. This will have a marked influence on the design, especially in the steam generating sections. More uniform use of the heat transfer surfaces may be expected and this taken with the elimination of the furnace volume will result in significant reductions in size of the steam generator. Structurally it will be necessary to place particular emphasis on tightness, for any leaks might result in contamination which might be troublesome on either side. This may require the use of corrosion-resistant alloys and almost complete welding of all joints. New provisions for cleaning and purging the steam side will be necessary as it must be possible to carry out these operations without exposing the operator to dangerous radiation. If molten metals are used, some means must be provided for draining the metal on shutdown or for melting it in place when starting up.

The reactor and the fluid heat transfer system have no close counterpart in the fuel burning station. They are entirely new elements. In bulk they probably will be rather smaller than the furnace combustion space for an equal output: Gilliland,[2] in one example, has assumed a reactor in the form of a cube ten feet on a side as appropriate for a 45,000-kw unit. To this must be added the heavy radiation shield of concrete or similar material and space for the fluid circulating pumps. There is no need to discuss again the general requirements for feeding fissionable materials and removing fission products. The control system quite certainly will be more complex than for the fuel burning station.

The nuclear power station will not be required to handle large weights of fissionable materials or fission products. On the other hand the intense radioactivity of the fission products will require elaborate, and probably bulky, equipment to permit safe handling.

The nuclear station will not require forced and induced draft fans, nor air preheaters, but there will be other auxiliary equipment of possibly equal bulk and about equal complexity.

If the reactor can be so designed that the fissionable materials, and the fission products, are tightly encased in metal capsules which are not opened until delivered to a chemical reprocessing and recovery plant, then the quantity of radioactive gaseous products will be limited and comparatively small and simple facilities will be adequate for their safe disposal. However, if this cannot be done, then there will be need for large and complex facilities. The fission products include significant amounts of radioactive krypton and xenon[4] and these gases would be difficult to dispose of as they do not form chemical compounds and can be liquefied only at very low temperatures.

The picture of a nuclear power plant that thus emerges shows a turbine room and electric equipment galleries quite like those in conventional coal burning stations, though with smaller but much more complex equipment where the boiler room and coal handling equipment had been.

ECONOMIC CONSIDERATIONS

What will such a plant cost, and what are the prospects that it can produce energy at a cost that will be attractive

economically? In answer we can do no better than to quote from recent remarks of Commissioner Sumner T. Pike of the Atomic Energy Commission before the National Industrial Conference Board:

> Now, let us try to examine the second half of the question which is that of economic competition with other methods of producing power. I suppose it is a fair approximation to say that the cost of power from any source is made up of its capital cost, its operating cost, and depreciation or obsolescence. Hydroelectric power, as we know, normally has a high capital cost, a very small operating cost, very small depreciation, and since a good hydroelectric plant operates close to top theoretical efficiency, almost no obsolescence. A steam plant, and now we are talking about the boiler end of the steam plant, since the nuclear reactor as power producer is merely the boiler end of the plant—the steam plant has characteristically a low capital cost, a high operating cost, largely for fuel consumption, and a medium rate of depreciation or obsolescence which, since the initial capital cost is quite low, has little effect on the ultimate cost of power. When we get to the question of cost of power for atomic energy, we might as well admit at once that we are all at sea on each one of the major factors of cost. Until we have made a machine that will operate at all, we can't have any accurate idea of the capital cost. Any cost estimates based on the presently available scanty data would indicate that the capital cost alone would be so high that if ever there were no operating or depreciation factors, interest on the capital alone would make the atomic power plant noncompetitive as against present methods of power production. This, however, should not be taken very seriously because as soon as the first practical working prototype is in operation, then the matter of capital costs can and will be seriously attacked, and if previous history is any indication, good research development and engineering skill will effect radical reductions. Operating costs will probably be high in the first instance. Only the future can tell about the cost of fuel. If exploration for large deposits of uranium is successful, which is a reasonable hope, operating costs for fuel can be pulled down into the practicable range. This is a question which only time and effort can solve and effort is being expended in this search. Labor costs on nuclear reactors will tend to be high at first, but as we work from the experimental zone it should be lowered gradually. When it comes to depreciation and obsolescence, we can expect to have very high rates at first and have no reasonable hope of expecting ever to get down to the low rates applicable to hydroelectric power production.

A few further comments may be added. In making a comparison of nuclear and fuel-burning power plants, it should not be assumed that they can be placed on sites equally advantageous with relation to the load. Until years of successful operation have proved their reliability, no prudent engineer would place a large nuclear power station in the heart of a large city or in densely populated or industrially very important areas. The ever present chance, however small, that something might go wrong and release large amounts of intensely radioactive material would dictate sites in areas where a failure would be less disastrous. Also, as mentioned before, the problem of safe disposal of radioactive products may raise problems that are solved much more easily in outlying areas.

Although it frequently has been suggested that nuclear power plants offered particularly attractive advantages in areas where adequate supplies of condenser cooling water were not available in lakes or rivers, this does not meet the test of critical analysis. As a heat engine—a steam turbine or a gas turbine—is required in either a nuclear or a fuel-burning plant, the conversion efficiency will be influenced equally by the availability or lack of cooling water. Higher final temperatures mean lower efficiency, larger turbines, steam generators, reactors, and so forth, and higher fuel consumption. All that can be said with certainty is that at some time in the future nuclear power plants may not be influenced as adversely as fuel-burning power plants by lack of natural cooling water supplies.

The last part of this discussion applies specifically to power plants for central power system supply and, quite clearly, it is not applicable to a number of other cases. For example, for ship propulsion, and especially in naval vessels, the possible savings in weight of "fuel" may offset a large increase in first cost and the hazards may be minor in comparison with others that are accepted. Each case involves distinct problems and it would be folly to argue from one to the other without checking the validity of the assumptions.

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Variable-Resistance Spring

A highly sensitive mechano-electrical transducer, which transforms slight displacements into large changes of resistance, current, or voltage, is being developed by W. A. Wildhack and his associates of the National Bureau of Standards, Washington, D. C. The active element of the device is a helical or conical spring wound in such a way that the initial tension varies slightly along its length. Thus, when the ends of the spring are pulled apart, the turns separate one by one rather than simultaneously.

When the spring is entirely closed, it has an electric resistance approximately that of a cylindrical tube. When it is completely open, its resistance is that of the total length of the coiled wire. Resistance thus can be varied over a wide range by stretching the spring. As the percentage change in resistance may be hundreds of times greater than the percentage change in length, displacements as small as 1/100,000 of an inch easily can be measured without the use of electric amplifying devices. The spring transducer thus provides a sensitive means for conversion of any mechanical displacement to a change in an electrical quantity that can be determined precisely. When connected to another transducer which gives a mechanical displacement output (a bimetallic strip responding to temperature changes, for example), the combination gives an easily measurable electrical output. This type of use suggests numerous scientific and industrial applications, including strain gauges, pressure elements, accelerometers, electric weighing devices, automatic temperature controls, d-c–a-c inverters, and voltage regulators.

To decrease contact resistance between successive turns of the closed spring, a high average initial tension is built into the spring, and the turns are coated with 0.0001 inch of gold. Thus far, nickel-alloy wire has been mainly used, because of its high resistivity and small change of mechanical properties with temperature.

The 230-Kv Ring Bus for Grand Coulee Power Plant

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GRAND COULEE POWER PLANT at Coulee Dam, Wash., is the largest hydroelectric power plant in the world and will have an ultimate installed capacity of over 2.3 million kw. This unprecedented concentration of generating capacity presents a real and worthwhile problem regarding the selection, design, and development of the most desirable bussing arrangement. It was concluded early in the studies of the various possible bussing arrangements that the three performance factors which should be given major consideration were:

(*a*). Circuit-breaker interrupting capacity.
(*b*). Stability.
(*c*). Ease of operation and flexibility.

Most present-day high-voltage transmission systems use a solid high-voltage bussing arrangement, or slight variations from it, because of the availability of quick-clearing high-interrupting-capacity circuit breakers. For all but the larger generating stations, present-day circuit-breaker interrupting capacities of 3.5 million kva permit the use of a solidly connected high-voltage bussing arrangement which gives a high degree of stability and flexibility of operation. However, in the case of Grand Coulee power plant, the installed and available circuit-breaker interrupting capacities were not sufficient to permit the use of a solid high-voltage bus. With the installation of only six of the ultimate 18 generating units, the degree of solid bussing was limited by the 3.5-million-kva interrupting capacity of the circuit breakers. Two solutions appeared available:

(*a*). Increase the circuit-breaker interrupting capacity to 10 million kva.

(*b*). Reduce the magnitude of the short circuit by sectionalizing the bus or by using bus-tie reactors.

The solution to this problem required extensive network analyzer studies and design and cost analysis, as well as field tests at Grand Coulee Dam to prove new circuit breaker designs of ultrahigh interrupting capacities. As the studies progressed, it soon became evident that the greatest ease of station and system operation would be obtained with a high-voltage bus solidly connected. With a solid bus, the power flow is such that the load is delivered with the smallest number of kilovars for a given line capacity. A 230-kv solid ring bus also will permit transferring power around the bus from a high generation section to a high load area up to the capability of the transmission lines. This requirement is particularly important when five generators are off the transmission system for pumping during the irrigation season and large blocks of power must be transferred from one bus section to another.

Final selection of a 230-kv ring bus for Grand Coulee power plant was based on the following conclusions:

(*a*). Maximum system operating flexibility with a symmetrical switching arrangement is obtained with a 5-section 230-kv ring bus.

(*b*). A high degree of over-all stability is obtained by the solid bus arrangement when using present-day high-speed circuit breakers and relays.

(*c*). The most important means for improved performance and simplicity of bussing arrangements was the use of high-interrupting-capacity 10-million-kva circuit breakers, such as shown in Figure 1.

(*d*). By use of a 230-kv ring bus, additional generation and corresponding line capacity can be added easily by adding bus sections.

(*e*). A main ring bus and a sectionalized auxiliary bus with double circuit breakers in alternate line positions provides the greatest operating flexibility and ease of maintenance at the least cost.

(*f*). The 230-kv ring bus with two parallel lines to each load center permits the installation of the simplest type of relaying, thereby increasing the reliability of operation.

The 230-kv ring bus which has been developed for Grand Coulee power plant will provide the required characteristics of flexibility, simplicity of operation, ease of maintenance, maximum stability, and simplicity of relaying at the most reasonable cost for operation of the world's largest hydroelectric power development. Essentially, the ring bus scheme consists of connecting the main busses in the 230-kv left and right switchyards together with two tie circuits crossing the Columbia River to form a closed ring to which all generators and lines are connected. The ring bus is divided into five sections through a bus-tie circuit breaker with each section containing three generators and two transmission lines so that in case of a bus fault only 20 per cent of the generation and line capacity would be lost.

Figure 1. A 10-million-kva 3-cycle 20-cycle-reclosing conventional tank-type 230-kv oil circuit breaker

Digest of paper 48-193, "Development of the 230-Kv Ring Bus for Grand Coulee Power Plant," recommended by the AIEE power generation committee and approved by the AIEE technical program committee for presentation at the AIEE Pacific general meeting, Spokane, Wash., August 24–27, 1948. Scheduled for publication in AIEE *TRANSACTIONS*, volume 67, 1948.

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Test of Ionization Level of Rubber-Insulated Cables

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IT HAS BEEN FOUND that the inception point of ionization or corona within electrical components, especially solid dielectric cables, should exceed the normal operating voltage of the component in order to eliminate deleterious physical and electrical effects associated with ionization. Most of the equipment so far developed to determine ionization point has been designed individually for specific laboratory applications and, consequently, presented certain shortcomings for general purpose and production use. Commercial equipment now has been developed to overcome such objections and has been applied successfully in laboratory and production testing. Destructive ionization occurs at voids or air spaces within the component or dielectric and since evidence necessary for a critical analysis of this action generally is destroyed through the mechanism of breakdown, the need for a method to detect voids by a nondestructive and practical means is self-evident.

Measuring equipment utilizing bridge circuits based upon transient analysis have been designed with high sensitivity, accuracy, and other advantageous features. However, the need for adjustable balancing capacitors and other complications indicated that a filter circuit might have advantages particularly where ease, speed, and range of measurement were dominant factors. This latter circuit has been incorporated in commercially built equipment which provides portability and compactness together with adequate sensitivity and accuracy. This has been made possible by elimination of ionization effects from all circuit constants, and the incorporation of a broad-band sensitive amplifier together with a cathode ray oscilloscope for visual detection.

Since terminations are usually a part of the device or cable under test, it is extremely important that they be free of surface leakage in the form of discharges that would be picked up readily at voltages considerably lower than the true ionization under measurement. The development and use of two distinct types of termination has proved successful for use in laboratory and production testing of cables in that they are simple, convenient to apply, and corona-free at the voltages encountered. These terminals consisted of

(*a*). Exponentially flared semiconducting neoprene stress cones filled with glycerine.

(*b*). Oil-filled insulated cylinder with mercury pool at one end.

It is possible to confine ionization measurements to short increments of cables through the use of a close-fitting tubular probe electrode which provides a nondestructive means of locating voids within a long length. Further analysis by dissection or X ray then may be used to determine the exact physical nature of the low ionization areas. Such a procedure has been used for analysis of factory cable repairs and may be advantageous in similar application to field splices and repairs.

Test data were obtained on nominally rated 5-kv oil-base rubber-insulated cables conforming to ASTM specification *D574*. Comparative tests showed that the ionization detector checked the results obtained by the more laborious interpretation of the power factor–voltage characteristics of the test specimen. It was discovered further that the power factor–voltage procedure indicated an average corona level for a long length of cable whereas the corona detector indicated the minimum point of ionization within the length. This is significant since the lowest value is associated with the weakest part of the cable.

Data disclosed a linear relationship might exist between breakdown voltage and ionization level. Other factors such as time of voltage application and temperature exhibited only minor effects upon ionization level. The cause and correction of low ionization was found to be associated with the cable design as well as manufacturing techniques. Elimination of porosity and voids, good concentricity, smooth contours, and close fitting coverings all contributed toward improvement of ionization level. The use of conductor adhesives and conductor shielding was investigated and found to have beneficial effects on ionization level.

The corona detector can be applied as a satisfactory production test on rubber-insulated power cables; such a test procedure is advantageous because of its nondestructive nature and as an indication that design and manufacture has been correct in producing a cable, or other electrical component as the case may be, whose ionization level is safely above its intended operating voltage. Considerable data also have been obtained upon polyethylene thermoplastic insulated types of power and communication cables. The expansion and contraction characteristics of polyethylene are so appreciable that very special extrusion and handling conditions must be observed if a void-free product is to be obtained. Since the ionization of voids in polyethylene cause rapidly deteriorating effects, it is already recognized that the ionization detector must be used as a production control test on any polyethylene cable intended to operate at voltages in excess of 1,000 volts if satisfactory performance is to be obtained.

The significance of ionization tests is not limited in its importance to cables. The very fact that the transformers, capacitors, connectors, and other circuit components used in the ionization detector unit itself required special treatments and, in some cases, redesign in order to obtain corona-free performance within their nominally rated voltage range, indicates a similar need for rigid investigation.

Digest of paper **48-198**, "The Measurement and Investigation of Ionization Level of Rubber-Insulated Cables," recommended by the AIEE insulated conductor committee and approved by the AIEE technical program committee for presentation at the AIEE Pacific general meeting, Spokane, Wash., August 24–27, 1948. Scheduled for publication in AIEE *TRANSACTIONS*, volume 67, 1948.

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Standards as Applied to Motors

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Motor standards are a very useful tool in the field of motor application. Study and knowledge of the standards will assist the purchasers and users of electric motors in doing a proper application job and in securing successful and uninterrupted operation.

THE EXISTENCE of American Standards means much to the purchasers and users of electric motors in their application of these machines. An important part of this consideration is the extent to which motors built by competitive manufacturers are alike and therefore interchangeable for application purposes.

THE STANDARD MOTOR

For purposes of illustration, the standard motor will be considered to be in accordance with AIEE, American Standards Association, and National Electrical Manufacturers Association Standards since there is no basic conflict between any of these Standards, but rather the differences that exist are in the extent to which the motor is defined.

Let it be assumed that a user of electric motors purchases a motor from each of the several companies which manufacture and sell motors in accordance with NEMA, ASA, and AIEE Standards. The purchase orders well might include the following standard specifications:

Type classification	Squirrel cage, general purpose
Voltage	220/440
Frequency	60 cycles
Phase	3
Horsepower	5
Synchronous speed	1800
Temperature rise	40 degrees centigrade
Duty	Continuous
Insulation	Class *A*
Design classification	*B*
Enclosure	Open
Frame size	254
Mounting	Horizontal, with feet
Terminal location	Standard
Balance	Standard

The Standards of AIEE, ASA, and NEMA as they may apply to these motors now may be considered.

AIEE STANDARDS

In the development of standards there must be certain fundamental standards set up as a framework on which more specific details can be built.

In electric motors, as in other electric equipment, the basis of rating is fundamental. AIEE Standard Number 1 establishes the basis of rating for electric machinery.

It has been established through the work of eminent engineers that class *A* insulation (organic insulating materials) will withstand successfully total temperatures of 105 degrees centigrade. In open-type motors, it has been established that temperatures measured on the surfaces of the windings by thermometer may be expected to be 15 degrees lower than temperatures in the hottest spot in the windings, and further that open-type motors for general service should be expected to operate successfully in ambient temperatures of 40 degrees centigrade. It therefore follows that a basis of temperature rating of open-type machines should be a measured temperature rise by thermometer, at rated conditions, of 50 degrees centigrade. However it is further recognized that motors for general service must be expected to be applied under conditions of load that are not accurately known in advance. Hence, the development of standards for general purpose motors, in recognition of these facts, provides for a factor of safety based upon a temperature rise, at rated condition, of 40 rather than 50 degrees centigrade. This permits a margin of 10 degrees rise which normally allows continuous overloads of 15 per cent without exceeding safe temperature on the insulation.

Other fundamental standards include methods of determining motor performance. The AIEE has established test codes defining the methods which may be used for testing various types of electric machinery. For polyphase induction motors, the test code is AIEE Number 500.

ASA STANDARDS

ASA has assembled a framework of standards developed from the basic AIEE Standards, which, for polyphase induction motors, are included in Standard *C-50* covering rotating electric machinery.

Broadly speaking, the ASA Standards define standard ratings, standard types of machines, and standard conditions of operation. They do not include dimensional standards or trade practices.

NEMA STANDARDS

NEMA Standards represent further expansion of the framework of standards, particularly in the direction of specific motor application standards.

It is in order to repeat at this point that there is no basic conflict in these standards. Each has a place and they serve the purpose of supplementing each other.

With reference again to the specific 5-horsepower motor,

Essentially full text of paper **48-138**, "Standards as Applied to Motors and Motor Applications," recommended by the AIEE Standards committee and approved by the AIEE technical program committee for presentation at the AIEE summer general meeting, Mexico, Federal District, Mexico, June 21–25, 1948. Not scheduled for publication in AIEE *TRANSACTIONS*.

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the characteristics may be examined in some detail as they are defined by the AIEE, ASA, and NEMA Standards. What have they in common as a result of these standards?

DIMENSIONS

Figure 1 gives dimensions and tolerances which would be common to all motors. If in addition slide rails were purchased with the motors, their mounting dimensions would be the same. From this it may be seen that the motors would be dimensionally interchangeable on the mounting base and to the connected load. Further, dimension sheets supplied with the motors would have standardized lettering of all significant dimensions.

TERMINAL MARKINGS

The terminal markings and connections would be in accordance with ASA *C 6.1-1944* and as shown in Figure 2.

MECHANICAL APPLICATION DATA

Type of Drive. The following types of drive would represent good practice:

(*a*). Flat belt. Standard pulley dimensions in inches are

Diameter	$4^1/_2$
Width	$4^1/_2$
Belt width	4
Pulley bore	$1^1/_8 \begin{pmatrix} +0.002 \\ -0.000 \end{pmatrix}$

Limiting pulley dimensions in inches are

Minimum pulley diameter	$3^1/_2$
Maximum width	$4^1/_2$

Inner face of pulley to be in line with shoulder on the shaft, with one-quarter inch from inner face of pulley to inner face of hub. Outside of hub to be in line with end of shaft.

(*b*). V belt. Limiting V-belt sheave dimensions in inches are

Minimum pitch diameter	$2^3/_4$
Maximum width of sheave	$4^1/_2$

(*c*). Gear.
(*d*). Chain. A limiting chain sprocket dimension is the minimum pitch diameter of 2.16 inches.
(*e*). Coupled.

Motor Vibration. The amplitude of vibration (total peak to peak displacement) would not exceed 0.001 inch when measured as defined in the NEMA Standards.

Electrical Application Data. These design classification *B* motors would be designed to withstand full voltage starting and the following characteristics could be counted on for application purposes:

Locked rotor current at 220 volts would not exceed 90 amperes.
Locked rotor current at 440 volts would not exceed 45 amperes.
Locked rotor torque would be 185 per cent of full load torque.
Breakdown torque would be 225 per cent of full load torque.
Slip at rated load less than 5 per cent with a variation in slip from that indicated by name plate speed of not more than 20 per cent.

These general purpose open motors are rated at 40 degrees centigrade, a conservative rating, and will carry continuously 1.15 times their rated load when operated at their rated voltage and frequency. This factor of 1.15 is known as a service factor.

The allowable variation from rated voltage for successful motor operation should be not more than 10 per cent above or below, but motor performance will not necessarily be in accordance with standards established for operation at rated voltage.

The allowable variation from rated frequency for successful motor operation should be not more than 5 per cent above or below, but motor performance will not necessarily be in accordance with standards established for operation at rated frequency.

The allowable combined variation of voltage and frequency for successful motor operation should be not more than 10 per cent above or below, but motor performance will not necessarily be in accordance with standards established for operation at normal rating. The Standards explain the effect of variation of voltage and frequency on the characteristics of the motors.

The Standards provide for the operation of general-purpose 60-cycle motors on 50 cycles. Briefly stated, the same breakdown and locked rotor torques in per cent of full load torque as given for 60 cycles, 440 volts, will be realized at approximately 415 volts, 50 cycles. Higher 50-cycle voltage will result in higher torque. The temperature rise of 440-volt 60-cycle 40-degree-centigrade-rise motors, in general, will not exceed 50 degrees centigrade when operated at 50 cycles at the same horsepower and with voltage between 415 and 440 volts.

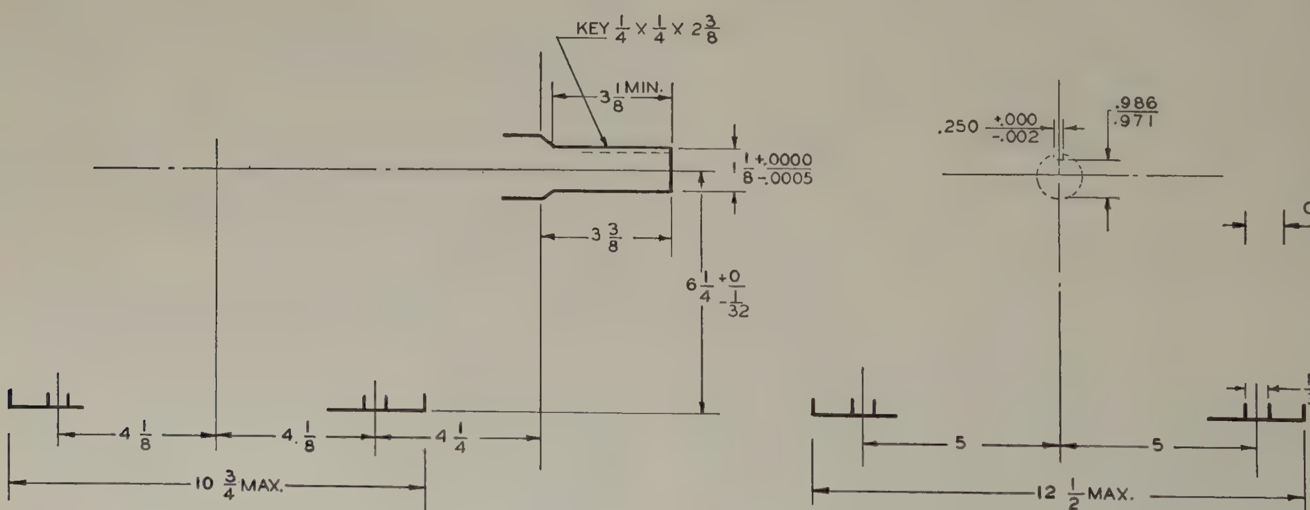


Figure 1. Standard dimensions and tolerances, NEMA frame 254

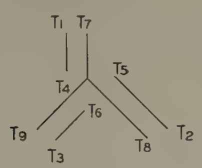
Name Plate Data. The following minimum amount of information will appear on the name plates of all of the motors:

1. Manufacturer's type and frame designation. (The basic NEMA Standard frame number 254 will be a part of this designation.)
2. Horsepower output.
3. Time rating.
4. Temperature rise.
5. Revolutions per minute at full load.
6. Frequency.
7. Number of phases.
8. Voltage.
9. Full Load amperes.
10. Code (letter indicating maximum locked kva.)
11. Design letter of motors.

Test and Curves. Motors will have received commercial tests as enumerated in the Standards. The complete engineering tests which the manufacturers will have made on motors of this rating will have been made in accordance with AIEE Number 500, Test Code for Polyphase Induction Motors.

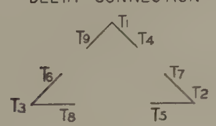
In the event the purchaser requests the manufacturer to supply reports of tests and characteristics curves, the data will be supplied on standard report of test forms and standardized characteristic curve forms.

Y CONNECTION



VOLTAGE	L_1	L_2	L_3	TIE TOGETHER		
LOW	T_1	T_2	T_3	T_1 T_7	T_2 T_8 / T_4 T_5 T_6	T_3 T_9
HIGH	T_1	T_2	T_3	T_4 T_7	T_5 T_8	T_6 T_9

DELTA CONNECTION



VOLTAGE	L_1	L_2	L_3	TIE TOGETHER		
LOW	T_1	T_2	T_3	T_1 T_6 T_7	T_2 T_4 T_8	T_3 T_5 T_9
HIGH	T_1	T_2	T_3	T_4 T_7	T_5 T_8	T_6 T_9

Figure 2. Standard connections and terminal markings, dual-voltage 3-phase induction machines

APPLICATION CONSIDERATIONS

It should be apparent to the user that because of the detailed Standards that have been produced, much is known about these motors that will aid in their proper application, and there is indeed much in common between the motors that he may purchase from the several manufacturers to permit him latitude in serving his applications.

However, for the moment it may be assumed that the particular standard motor that has been discussed does not meet the user's application requirements.

How broad then are the standards from which he may make the proper selection to meet his requirements? In the interest of brevity, Table I covers the significant range of the American Standards for large power polyphase induction motors.

These Standards are not static but constantly are being expanded and clarified to assist purchasers and users in their job of proper application. Among recent additions to the Standards, two major developments may be cited.

The first is the expansion of the coverage of 50-cycle motors. Performance characteristics now are covered about as completely as are 60-cycle motors.

The second is the recent revision pertaining to design classes of motors. The Standards of locked rotor torque and breakdown torque are much more realistic of the values built into the motors than had been previously true. Because of the importance of torque and slip values to proper applications, representative applications of each of the design classes are included here:

Design A. This may be described as a relatively high starting current, normal torque, normal slip motor. Its field of application is the same as design *B*. Its purpose is to cover motor designs wherein considerations may make impractical meeting the starting current limitations of design *B* motors, for example, the larger totally enclosed fan-cooled motors.

Design B. This is the basic standard motor. It has low starting current, normal torque, and normal slip. Its field of application is very broad and includes fans, blowers, pumps, and machine tools.

Design C. This motor has high starting torque, normal starting current, and normal slip. Its field of application includes compressors and conveyors which may have high starting torque requirements.

Design D. This motor is the high slip motor. It has high starting torque and normal starting current. It may be built in a number of types but its field of application is principally for punch presses, shears, and other high impact loads.

Design F. This is an infrequently used motor. It has very low starting current, low breakdown torque, and normal slip. Its field of application is where starting current limitations are severe and where breakdown torque requirements are low.

Table I. Extent of American Standards for Large Power Polyphase Induction Motors

1. Frame Standards	16 frame sizes, 203–505 inclusive; including slide rails
2. Frame mounting	12 standard mounting positions covering floor, wall, and ceiling mountings
3. Flanges	3 standard flanges, types *C*, *D*, *P*
4. Enclosure	Included in standard ratings and frame: Open, splashproof, totally enclosed, totally enclosed fan cooled. Covered by definition only: Many other types
5. Shafts	Standard, direct coupled, standard taper for tapered shafts
6. Terminal marking	ASA *C-6.1* covers all types
7. Balance	Method of measurement, limits of vibration
8. Mechanical drives — flat belt, V-belt, gear, chain, coupling	Speed limitations, horsepower limitations. Limiting dimensions of pulleys, sheaves, sprockets
9. Classification	Squirrel cage—constant speed, multispeed; wound rotor
10. Voltage	110, 208, 220, 440, 550, 2,300 volts
11. Frequencies	60, 50, 25 cycles
12. Phase	Two and three phase
13. Horsepower rating	1/2–200 hp, inclusive; 150-hp maximum assigned to standard NEMA frame
14. Speed ratings	2–16 poles
15. Design classes — squirrel cage	Design *A*, *B*, *C*, *D*, *F*
16. Duty	Continuous, short time
17. Types of insulation	*A*, *B*, *C*, *O*. Type *H* (silicone) covered by AIEE Standard 1
18. Service conditions	Usual, more favorable, less favorable
19. Tests and data	Commercial tests, method of testing, report of tests, forms for characteristic curves, lettering of dimension sheets
20. Special applications	Elevator, crane, shell type, hermetically sealed, and buffer and grinder motors

Tests at 500-Kv Station at Chevilly

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THE 500-kv experimental station of Chevilly, near Paris, France, has been built with a view to making a close study of the behavior of the lines to be used when building up the French 400-kv system. Present economic conditions in France do not favor the use of copper conductors, in consequence two solutions have been considered for the equipment of these lines:

1. Utilization of large diameter (1.58 to 1.97 inches) "expanded aluminum-cable steel-reinforced (ACSR)" conductors.

2. Use of a bundle of two conventional ACSR (1.04-inch-diameter) conductors, the total cross section of which is equal to the economic section.

To facilitate at the opportune moment the rapid layout of a 400-kv system, while meeting the future needs for extension of the existing 230-kv system, the new high-capacity transmission lines of the latter are being designed in the form of double-circuit 230-kv 6-conductor lines laid on a horizontal plane and convertible into single-circuit 400-kv lines. Thus was built the line Le Breuil–Chevilly which is 252 miles long and is equipped with six standard 0.638-square-inch ACSR conductors. It was placed in operation in December 1946.

When this line is converted into a single 400-kv line, if single large-diameter conductors be utilized, the six conductors now in use will have to be taken down. If, however, the bundle technique is adopted, the conversion of the line will be obtained through a mere regrouping of the six conductors now in operation into three bundles of two conductors each. This second method is not only quicker than the first but offers also the advantage of utilizing only standard cables.

The station of Chevilly was built mainly for carrying out experiments and comparisons on the two methods as regards corona losses and radio influence under all kinds of atmospheric conditions, for selecting the optimum operating voltage, for determining, when utilizing bundle conductors, the most favorable spacing between conductors, and finally for studying insulators and line hardware. Studies of spacing included consideration of the corona effect, the sticking of conductors under the effect of the wind and electrodynamic stresses due to short circuits, also their disposition either on a vertical or horizontal plane.

In order further to study the influence of air density on the corona effect (some lines of the French system having to be strung of their length about 6,500 feet above sea level) two more experimental stations have been built, one at Chevilly, close to the 500-kv line, and the other in the Alps at Alpe d'Huez, 6,000 feet above sea level.

GENERAL CONCLUSIONS

A general survey of the theoretical studies and tests which have been carried out for the last 18 months leads to the positive conclusion that it is possible to operate a line of the same type as the experimental line of Chevilly under a phase-to-phase voltage equal at least to 400 kv with a frequency of 50 cycles.

Should the technique of two bundle conductors be adopted, the right spacing will be 16 to 20 inches, with which corona losses are but little over the minimum corresponding to the conductors utilized (1.04-inch diameter) and for which the minimum number of spacers per 1,640-foot span to avoid conductors sticking does not exceed two for conductors bundled in a horizontal layout. When the bundle is laid vertically, no spacer is required, which makes this layout more advantageous in this respect; it means, however, slightly higher towers, therefore, a slight increase in the cost of erection of the line.

With an operating voltage of 400 kv, losses in fine weather are less than 0.8 kw per mile and are comparable to those on existing 230-kv lines; they are therefore much lower by comparison with the transmitted power. Losses in bad weather are much higher, but if allowance is made for the alternate spells of dry and wet weather, the total amount of power lost through corona is perfectly admissible.

As regards the influence of altitude, the experiments carried out at the two 230-kv stations proved the accuracy of Peterson's formula, according to which the voltage corresponding to a given value of losses varies in inverse ratio to $\delta\ 2/3$, δ being the relative air density.

Estimates based on the recordings made at Chevilly as well as on a survey of the route covered by the Le Breuil–Chevilly line (252 miles long) with consideration also of the rainfall and the differences in altitude along this same route, make it possible to figure the average of corona losses per annum at about 4 kw per mile if this line were operated under a mean voltage of 400 kv. Under 440 kv, losses would be two to three times higher, which still would be admissible.

In reality the limitation of the operating voltage will depend on radio disturbances; it is not certain that it may be possible in this respect to go much over 400 kv, at least not without increasing the diameter of conductors at certain points.

With regard to expanded conductors, experimentation has not been going on long enough as yet to be able to draw definite conclusions on the subject: in particular, all types of cables have not been tested. For the time being it appears that expanded conductors seem to give much higher losses than the bundle conductors, especially in dry weather.

Digest of paper **48-199**, "Results of Tests Carried Out at the 500-Kv Experimental Station of Chevilly (France), Especially on Corona Behavior of Bundle Conductors," recommended by the AIEE transmission and distribution committee and approved by the AIEE technical program committee for presentation at the AIEE Pacific general meeting, Spokane, Wash., August 24–27, 1948. Scheduled for publication in AIEE *TRANSACTIONS*, volume 67, 1948.

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Transmission System From Grand Coulee

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THE TRANSMISSION SYSTEM of the Bonneville Power Administration transmits power from the Grand Coulee project to three major load centers in the states of Washington and Oregon. The project will have an ultimate peaking capability of about 2,300,000 kva, which will result in the largest concentration of electric power from one hydroelectric dam in the world. The immediate problem of transmitting this large amount of power from Grand Coulee to the load centers is to a certain extent overshadowed by the fact that the Columbia River Basin has a possible economical development of over 10,000,000 kw, and whatever circuit arrangements are made at Grand Coulee will influence the planning and design of the other future generating stations and transmission systems.

A number of studies have been made to determine appropriate transmission line and switchyard connections at Grand Coulee which will best meet the load, operating flexibility, stability, economy, and other requirements of the over-all system. Three schemes were investigated:

1. Parallel line pairs fed from isolated busses.
2. A sectionalized ring bus with various amounts of reactance between bus sections.
3. An interleaved line scheme which provides synchronizing power between bus sections.

The results of the studies show that by use of a high-voltage transmission grid considerable over-all economy will be obtained. The transmission grid requires fewer lines and utilizes heavier line loadings to load centers without any sacrifice in stability. Such a grid requires the bussing of generators and lines at Grand Coulee, but with the resultant disadvantages of very high circuit breaker duty and increased switchyard and circuit breaker costs. When all generators are bussed directly, the greatest operating flexibility is obtainable, but circuit breakers of from 12 to 15 million kva will be needed in the ultimate development. However, if the bus is sectionalized with a small amount of reactance between sections, a material decrease in circuit breaker duty is obtained, as indicated from the curves of Figure 1. The figure shows that approximately the same degree of stability is obtained by either a solid bus or a 12 to 13 per cent reactor, but a 6 per cent reactor gives a greater degree of stability. The reduced oscillation with optimum reactors must be evaluated as a greater margin of safety with which to meet the fault condition during a time when some other line or facility is out of service. A small reactance between bus sections also increases the transient stability of the system. The reactors increase the cost of the installation somewhat, and future operating conditions may arise where the current-carrying capacity of the reactors may be exceeded.

As a result of these studies, a 5-section 230-kv ring bus with sectionalizing circuit breakers was adopted. Three-cycle line circuit breakers of 10,000,000-kva interrupting rating will be used, and provision has been made to allow for installation of bus sectionalizing reactors at a future date. The sectionalized ring bus, in addition to meeting other requirements, makes it possible to maintain transient stability following a bus fault, or in the event of failure of equipment to clear a line fault. Such an occurrence makes it necessary to lose only one bus section, since necessary synchronizing power can flow between other bus sections and other parts of the transmission system.

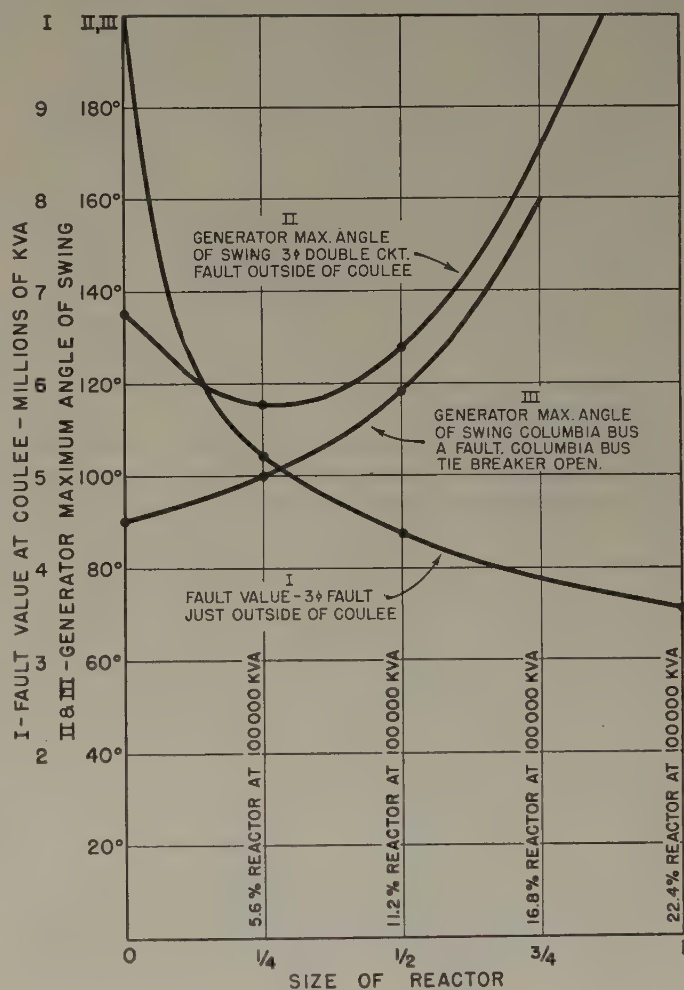

Figure 1. Effect of reactor size on circuit breaker duty and relative stability

Five-section ring bus with 5 bus tie reactors, 17 generators, no pumping

Digest of paper **48-196**, "Development of the Transmission System From the Grand Coulee Power Plant," recommended by the AIEE transmission and distribution and power generation committees and approved by the AIEE technical program committee for presentation at the AIEE Pacific general meeting, Spokane, Wash., August 24–27, 1948. Scheduled for publication in AIEE *TRANSACTIONS*, volume 67, 1948.

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The "Phantastron" Control Circuit

JAMES R. McDADE

A single-tube control circuit has been devised which had important application in delay circuits for radar use. This article, in which the circuit is described, was awarded the AIEE Student Branch paper prize for the academic year 1946–1947.

THE rapid development of the science of electronics during the war period in the form of radar, sonar, and television has led to and been supported by continuously improved and increasingly complicated control circuits, for control circuits form the heart of any application in which discontinuous-type actions are performed. These have advanced from the realm of single tube relaxation oscillators and spark gap modulators to a position of major importance sometimes involving the use of scores of tubes for the single purpose of obtaining accurate control of transmission and indication. The well-known multivibrator circuits have been widely utilized as master control circuits, often growing into large proportions as successive additions and supplementations were added in order to provide increased stability and linearity of control.

In this article will be presented a description and explanation of one of the newer types of control circuits, the "phantastron." The circuit has had important application in the famed "bombing-through-overcast" radar sets *AN/APS-15*, *AN/APQ-13*, and *AN/APQ-23*, and, in view of its improvement over conventional-type delay multivibrator circuits, it no doubt will find extensive application in the television field. A comparison of the characteristics

Figure 1. Construction of 6SA7 tube

of the delay multivibrator and the phantastron is included in Table I. This comparison has been extracted from a Massachusetts Institute of Technology Radiation Laboratory report.

TUBE AND CHARACTERISTICS

In the following discussion an acquaintance with the characteristics of ordinary negative-resistance trigger circuits is assumed and explanation is based on this foundation.

In preface to discussing the actual circuit, it will be profitable first to investigate the tube which forms the heart of the timing circuit.

A *6SA7* supercontrol pentagrid converter tube is employed. The tube was developed originally for providing a highly stable frequency source when employed as a converter. This was afforded by a special type of construction which was such that a change in signal grid voltage produced little change in cathode current. This of course reduced to a minimum the degenerative and regenerative effects of the cathode impedance.

This type of operation is accomplished by the construc-

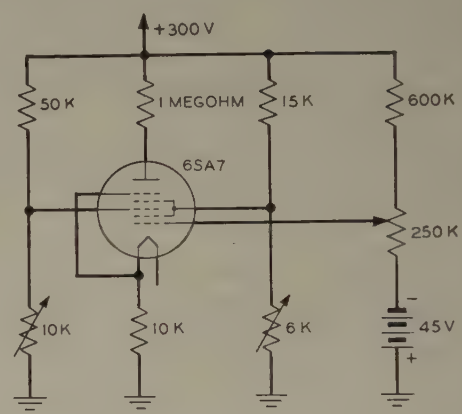

Figure 2. Circuit for obtaining characteristic curves

tion illustrated in Figure 1. In order to give grid 3 a supercontrol characteristic, its support rods are placed in the electron stream. This splits the electron beam necessitating the addition of collector plates on grid 2 to collect the excess electrons. The number of electrons which reach the plate is controlled by grid 3. However, grid 3 does not control the number of electrons emitted from the cathode. This function is performed by grid 1 such that if grid 3 allows plate current to flow, it can be con-

Table I. Comparison of Delay Multivibrator and Phantastron for 150-Microsecond (20,000 Yards Range) Maximum

Item	Delay Multivibrator	Phantastron
Linearity of duration delay versus control volts	±0.25 per cent from 3–9 to 150 μsec	±0.1 per cent from 5 to 150 μsec
± 10 per cent change in filament voltage about the value 6.3 v	±0.5 per cent change in duration	±0.15 per cent change in duration
±10 per cent change in *B* voltage about the value of 250 v	±5 per cent change in duration	±0.15 per cent change in duration
Temperature coefficient (per cent change in duration per deg C)	−0.005 per cent	−0.002 per cent
Maximum over-all sensitivity to all tubes	±10 per cent change in duration	±5 per cent change
Microphonics (light tapping of tubes)	±2 per cent change in duration	±0.2 per cent change in duration

Essential substance of a paper "The Phantastron Single Tube Control Circuit," presented at the South West District Student Branch conference held at the University of New Mexico, May 6, 1947; subsequently awarded the AIEE national prize for Branch paper for the academic year ending June 30, 1947, which award was presented at the Institute's recent 1948 summer general meeting.

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trolled to some extent by grid 1. The cutoff bias for grid 3 is approximately 6 volts (with respect to cathode). For biases greater than 6 volts on grid 3, electrons emitted from the cathode and passing through grid 2 are repelled back to it by the negative voltage on grid 3. All the electrons emitted by the cathode then are collected by grid 2 and grid 1 (if sufficiently positive). The characteristic curves for the *6SA7* were obtained by utilization of the circuit pictured in Figure 2. Curves of plate current versus grid 1 potential for various values of grid 3 potential are plotted in Figure 3. It may be seen immediately that the negative-resistance-type characteristics are obtained. A particular sample sheet taken with grid 3 potential at +25 volts with respect to ground is shown in Figure 4. In order to analyze the tube action over the various values of grid 1 voltage, this figure will be utilized.

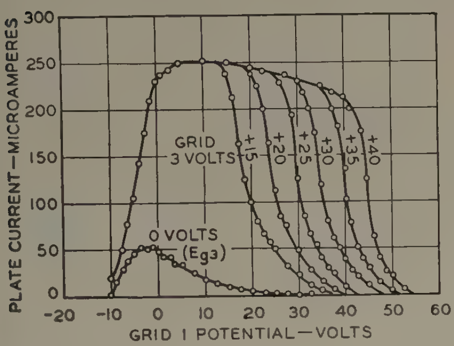


Figure 3. **Plate current versus grid 1 potential for various values of grid 3 potential**

Beginning at a highly positive value of grid 1 potential, say 65 volts, it may be seen from the curves that plate current is zero. From Figure 5 (and from the circuit itself) the reason for this lack of plate current is seen to be high grid 3 bias. Grid 1 bias is slightly positive which accounts for the high grid 1 current—approximately 3 milliamperes. At this point the cathode current is dividing practically equally between the grids 1 and 2. Excessively high grid 1 potentials will cause the grid 1–cathode elements to act as a diode, robbing grid 2 of its current.

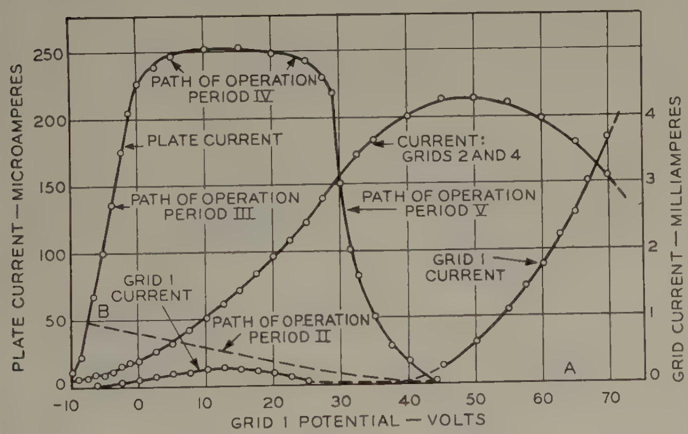


Figure 4. **Curves of plate and grid currents versus grid 1 potential (grid 3 potential constant at +25 volts)**

As grid 1 potential is decreased, its bias approaches zero with a consequent decrease in grid 1 current, the extra current going to grid 2 causing its current to increase. This process continues until, at approximately 40 volts potential on grid 1, the bias on grid 3 rises to cutoff and the plate begins to draw current. As grid 1 potential decreases, the voltage on the cathode will decrease and the grid 3 bias will decrease, allowing plate current to increase.

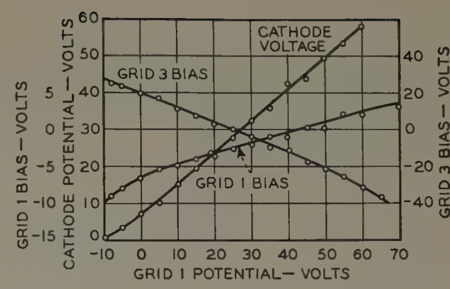


Figure 5. **Cathode voltage and grids 1 and 3 biases versus grid 1 potential**

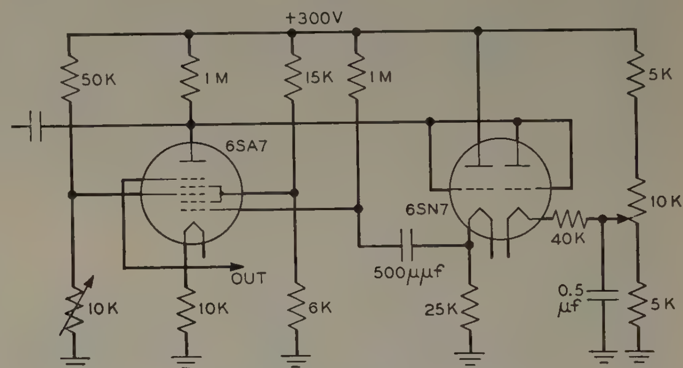


Figure 6. **Typical phantastron control circuit**

This continues until the compensatory effects of a decreasing grid 1 potential tending to decrease cathode current just balances the effect of a decreasing grid 3 bias tending to increase plate current. That this balance occurs over a wide range of values for grid 1 potential is shown by the flat portion of the curves, Figures 3 and 4. The effects of variation of grid 3 potential on the limits of this flat balance also are shown on Figure 3 for values of grid 3 potential ranging from 0 to +40 volts.

PHANTASTRON DELAY CIRCUIT

A typical schematic illustrating the phantastron delay circuit is given in Figure 6. The heart of the circuit is the phantastron tube itself, the *6SA7*. The *6SN7* serves double duty, the left portion acting as a cathode follower, the right as a disconnecter diode, both elements functioning to prevent excessive loading of the plate circuit of the *6SA7* when it is conducting.

In discussing the action of the circuit the gain of the cathode follower is assumed to be unity. While this is not strictly correct, it is of no qualitative importance so far as the general theory of the circuit is concerned.

Wave forms obtained from the circuit are shown in Figure 7 for conditions of control voltage of 250 volts and grid 3 voltage of 25 volts with respect to ground.

Inasmuch as several different actions occur simultaneously within the circuit, it will be necessary to consider each discontinuous part of the wave form individually. Accordingly, the discussion will be divided into six periods corresponding to those indicated in Figure 7.

PERIOD I

This is the normal quiescent operating period before the application of a trigger. Plate current is cut off due to the high grid 3 bias. Grid 1 bias is approximately positive 1.3 volts, causing a rather large flow of current from both grids 1 and 2 to the cathode (grid 1 is tied to B+ through 1 megohm, affording the positive bias condition). The cathode and grids 1 and 2 are acting as a triode conducting at approximately 0 bias. The plate potential is held constant at the control voltage (+250 volts) by the diode disconnecter tube.

PERIOD II

This period is initiated by a negative pulse of approximately 25 volts applied to grid 1. For easiest explanation, consider the pulse to be rectangular, the duration of the period corresponding to the duration of the pulse. The pulse is transmitted through the cathode follower onto grid 1, causing its potential to drop. (It also extinguishes plate current in the disconnector diode.) As the potential of grid 1 falls, the cathode potential falls with it (see Figure 5). As the cathode voltage decreases, the bias on grid 3

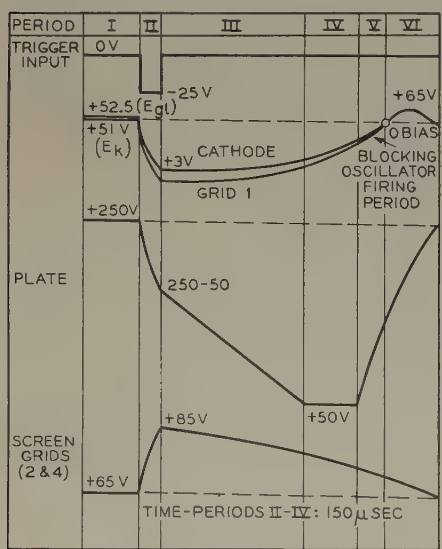
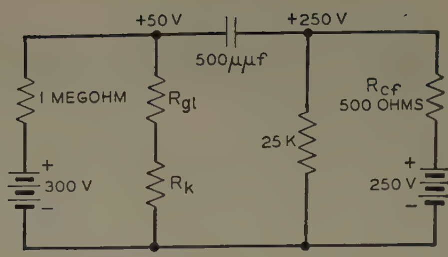


Figure 7. Expanded wave forms — output of phantastron

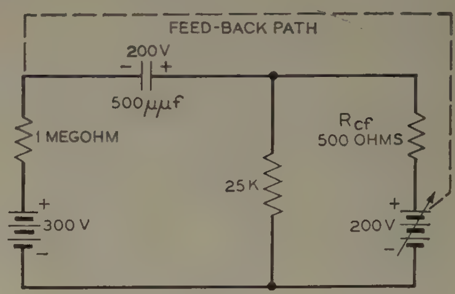
also falls, eventually passing cutoff and allowing plate current to flow. The drop in plate voltage is determined by the plate to ground capacity as it discharges through the tube. As the plate current increases, the plate voltage drops further, which drop is fed back through the cathode follower onto grid 1 carrying it down still further, the action being regenerative. Assuming that the 500 micromicrofarad capacitor does not change its voltage during this period (time constant for this capacitor being approximately 250 microseconds), the potential by which the plate drops determines the drop at grid 1. This process acts along a line *A-B* (Figure 4) which terminates on a point satisfying the tube characteristics for a fixed grid 3 potential of +25 volts. That is, with grid 3 potential fixed, the cathode will fall until the grid 3–cathode bias allows an amount of plate current to flow such that the sum of plate current and screen grid current give the required cathode potential across the cathode resistor.

Figure 8. Prepulse circuit conditions



This point is represented by point *B* on the tube characteristics. It should be noted that this drop depends on the time constant of the plate to ground capacitance and upon the grid 3–cathode characteristics. It is practically

Figure 9. Equivalent circuit — discharge transient



independent of the plate voltage (within the range of voltages used such that the amplification factor is constant).

PERIOD III

The 500 micromicrofarad capacitor was charged initially to the control voltage minus the initial grid 1 potential, which, for all purposes, was identical to the cathode potential. This capacitor now proceeds to discharge. The static prepulse equivalent circuit is given in Figure 8 with the discharge circuit in Figure 9. After the tube

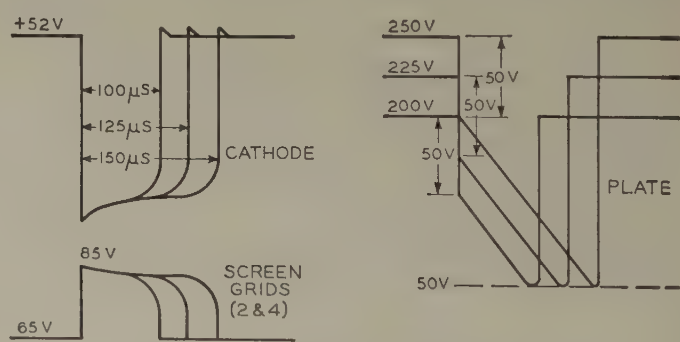


Figure 10. Experimental wave forms

draws plate current, grid 1 itself draws no current so discharge must occur through the 1-megohm grid leak resistor. The capacitor would like to discharge with the approximate goal voltage of 300 volts with a time constant of 500 microseconds. However, as the left side of the capacitor starts to rise, grid 1 increases from its value *B* and, as may be seen from the tube characteristics, this action causes plate current to increase. Consequently the plate voltage falls and this is fed back through the capacitor to grid 1, counteracting its rise. Thus the tube acts to prevent the capacitor discharge or to give the effect of a prolonged time constant.

The initial slope of the grid wave form may be obtained by differentiating

$$e_g = E_{bb}\left(1-\epsilon^{-\frac{t}{R_gC_g}}\right)$$

$$\frac{de_g}{dt} = -\frac{E_{bb}}{R_gC_g}\epsilon^{-\frac{t}{R_gC_g}}$$

and, at $t=0$

$$\frac{de_g}{dt} = \frac{E_{bb}}{R_gC_g}$$

Then, in a region of moderate g_m, the time constant at the plate will be approximately μR_gC_g, in our case 30×500 microseconds or 15,000 microseconds. For all practical purposes, then, the plate has a linear wave form during this period.

The period ends when, due to the characteristics, plate current ceases to increase with increasing grid 1 voltage; that is, when the plateau part of the curves is reached. This is, by definition, a region of low g_m, which means that the wave form of plate voltage becomes nonlinear. Note that the actual value of maximum plate current is dependent neither on grid 3 potential nor on the value of control voltage on the plate. Thus the plate will fall to a final value independent of control voltage setting so long as the circuit elements are unchanged.

PERIOD IV

This period is constituted by the time taken for capacitor discharge to allow grid 1 to pass through +5 to +20 volts during which time the plate current (and the plate voltage) are constant (the flat portion of the curve, Figure 4). Grid 1 and cathode voltage will continue to rise but with a shorter time constant, feedback being unavailable. This period is explained by the action of a rising voltage on grid 1 increasing *cathode* current and hence cathode voltage. Increasing cathode voltage increases grid 3 bias which tends to decrease *plate* current. The net result is for plate current and plate voltage to remain constant.

PERIOD V

During period 5, the effect of the rising cathode voltage in increasing grid 3 bias and thus cutting off plate current is more predominant than the grid 1 rising and trying to increase plate current. An increasing grid 1 voltage now causes plate current to *decrease* or plate voltage to *increase* which increase is fed back to grid 1 causing it to increase further. At some point along the cycle grid 1 will become sufficiently positive to draw current and will conduct at 0 bias. The rising of the plate voltage is determined by the sharpness of the grid 3-cathode cutoff characteristic and the rate at which the plate-to-ground capacitance will charge.

PERIOD VI

The plate now must return to control voltage (charging through plate-ground capacitance) and grid 1 must resume the quiescent value for cathode potential. The cycle is now complete; the circuit has regained normal quiescent operation and will remain thus until the incidence of the next trigger pulse.

SUMMARY

1. The initial drop (during period II) of the plate voltage is constant, independent of control voltage setting (within limits, of course).

2. Period III is nonlinear toward the end of the period since the tube is operating in a region of low g_m.

3. The voltage to which the plate falls is for all purposes constant regardless of control voltage setting.

4. The recovery time from period III to period V is for all purposes constant. A blocking oscillator is fired sometime during the rise of voltage in period V.

5. Change of duration of wave form varies essentially in a linear fashion with change of control voltage setting. This may be verified by an inspection of the wave form, keeping in mind points 1 through 4. (Duration of period III depends directly on control voltage.)

6. Wave forms are greatly exaggerated in so far as time is concerned. Periods II, IV, and V are very short whereas period III is very long. Actual experimental wave forms are given in Figure 10.

Atomic Motor

This is an atomic-motor model, which was a feature of the Westingthouse "Theater of Atoms," at New York City's Golden Anniversary celebration held at Grand Central Palace, August 23 to September 19, 1948. A 200,000-volt charge is transmitted to each of seven copper spheres mounted on a plastic wheel. The spheres pick up this charge and are driven away from the miniature atom smasher by electric repulsion. As a result, the "motor" spins around at speeds up to 100 revolutions per minute. The future hope of scientists is that a lump of radioactive material will replace the electric charge of the smasher to make possible the direct conversion of atomic energy into electric energy

Electrical Essay

Electrical Heat Generation in Metal Bar

A STRAIGHT metallic bar, of uniform section, maintained at a constant uniform temperature, has flowing through it at constant density a steady, continuous current of magnitude I. The electric equipotential surfaces are the plane sections of the bar, perpendicular to its edges.

By some suitable method, the difference in potential $V_A - V_B$ between two such sections is determined. Also by some suitable method, the rate of removal of heat Q_{AB}, from the volume of the bar between the sections A and B, which is necessary to keep the bar temperature constant, is determined.

Then always $(V_A - V_B)I$ and Q_{AB} are equal in magnitude.

True or *false?*

Answer to Previous Essay

The following is the author's reply to his previously published essay (*EE, Sep '48, p 904*).

The author's answer is *false.*

The family of curves

$$S_1;\ y=\frac{4}{\pi}\left[\cos\theta\right]$$

$$S_2;\ y=\frac{4}{\pi}\left[\cos\theta-1/3\cos 3\theta\right]$$

$$S_3;\ y=\frac{4}{\pi}\left[\cos\theta-1/3\cos 3\theta+1/5\cos 5\theta\right]$$

$$S_4;\ y=\frac{4}{\pi}\left[\cos\theta-1/3\cos 3\theta+1/5\cos 5\theta-1/7\cos 7\theta\right]$$

and so forth, approaches the curve shown by the heavy line

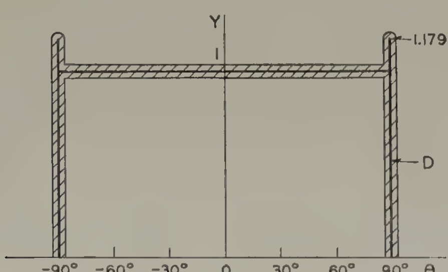


Figure 1

D in Figure 1 of this reply and not the curve C shown in Figure 1A of the essay.

To see this, we first must define what we mean by saying that the curve D is the limit of a sequence of curve S_1, S_2, S_3, ... and so forth. This we do as follows. Surround the ostensible limit curve D by a strip or belt of width ϵ (shaded strip in Figure 1). Then D is the limit curve of the sequence if, no matter how small the belt width ϵ is made, we always may go far enough along in the sequence, S_1, S_2, S_3, ... So that all the curves in the sequence beyond this point will be each respectively entirely within the belt of width ϵ.

The curve C of Figure 1A of the essay is not the limit curve of the sequence S_1, S_2. . . according to this definition. The last arches to the right of S_1, S_2, S_3, S_4, are shown in Figure 2 of this reply. The heights of these arches do not approach the value 1.000 as we proceed in the sequence, but approach the value 1.179. Hence, if we draw a narrow

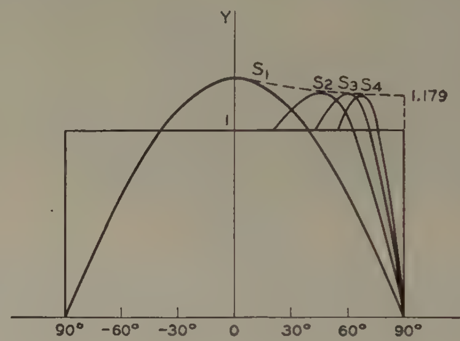


Figure 2

belt about the curve C, the sequence members, S_1, S_2, S_3. . . . all protrude outside the belt, no matter how far along we may go in the sequence.

This peculiarity in the convergence of the curves represented by partial sums of a Fourier series at a discontinuity in its generating function, is called "The Gibb's Phenomenon," in honor of its discoverer, J. Willard Gibbs, America's greatest native-born scientist.

The sequence of functions given by

$$F_1(\theta),\ y=\frac{4}{\pi}\left[\cos\theta\right]$$

$$F_2(\theta),\ y=\frac{4}{\pi}\left[\cos\theta-1/3\cos 3\theta\right]$$

$$F_3(\theta),\ y=\frac{4}{\pi}\left[\cos\theta-1/3\cos 3\theta+1/5\cos 5\theta\right]$$

$$F_4(\theta),\ y=\frac{4}{\pi}\left[\cos\theta-1/3\cos 3\theta+1/5\cos 5\theta-1/7\cos 7\theta\right]$$

and so forth, has as its limiting function, the function $G(\theta)$ defined as follows:

For θ between -90 degrees and $+90$ degrees,	$G(\theta)=1$	-90 degrees $<\theta<$ $+90$ degrees
For $\theta=-90$ degrees	$G(\theta)=0$	
For $\theta=+90$ degrees	$G(\theta)=0$	

J. SLEPIAN (F '27)
(Associate director, Westinghouse Research Laboratories, East Pittsburgh, Pa.)

The Space Charge Due to Corona

OTTO J. M. SMITH
MEMBER AIEE

A NEW TECHNIQUE for measuring the field strength and deducing the ion density about a wire in corona is needed. One such new method is measurement of a-c corona directly with a crystal galvanometer connected between two probe screens. The net space charge density was derived from the field strength curves in a single mathematical step, using Poisson's equation. The amount of charge present may be shown quantitatively by using a special function of the charge density. This is the total net charge contained in a cylindrical shell, one centimeter long, one centimeter thick, and of a parametric radius R. This total net charge is designated by Q. It is a convenient notation, for Q does not vary as a cloud of ions moves radially, but can change only by diffusion, recombination, or the introduction of new ions.

$$Q=2\pi\rho r=1/2\ (E+r\ dE/dr)$$

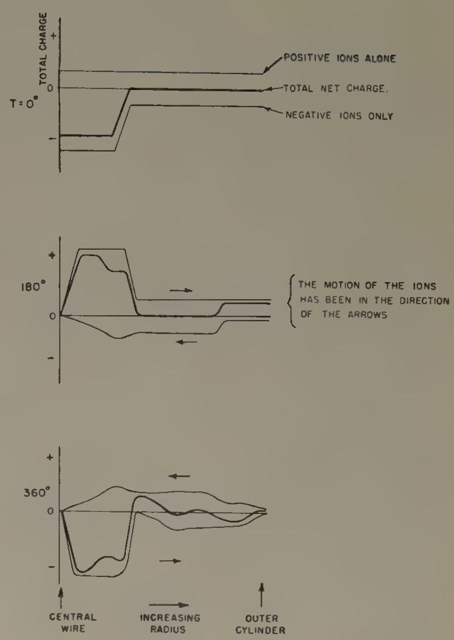
The area under a curve of Q versus r is the total net charge contained in the entire electric field per centimeter axial length of the cylinder. The area under the curve of Q between two co-ordinates r' and r'' is the total net charge per unit axial length in the cylindrical shell of internal radius r' and external radius r''.

The total charge can be determined graphically from the curve of field strength versus distance. The construction is shown in Figure 1. The line AB is drawn tangent to the field-strength curve at the point A, which corresponds to the parametric radius R. This line has a slope of dE/dr. It intersects the ordinate line for the radius $2R$ at the point B. The vertical distance between A and B is equal to the term $r\ dE/dr$ in the equation. The vertical distance from R to A is equal to E in electrostatic units. Since the slope is negative, $(E+r\ dE/dr)$ is equal to R to A to B, or the distance from point $2R$ to B. Since Q is one half of this value, a line is drawn from the origin to the point B, interesecting the ordinate RA at the point C. RC is the total net charge Q in electrostatic units if the field strength E is so measured.

The research showed the mechanism of the ion motions to be similar to that represented in Figure 2. At zero time, a body of ions is assumed to be left over from the previous negative corona, and elsewhere there is a uniform distribution of positive and negative ions. During the positive half cycle, the negative ions would move toward the wire. A few low-mobility ions would be left near the outer limits of the corona-ion penetration. A large number of positive ions would be introduced due to the new corona, and these would have higher mobilities and move farther than the old negative ions coming in at large radii. At the end of the first 180 degrees, three distinct regions can be recognized. During the next half cycle, the positive ions would be pulled back, and a space charge due to negative corona fed out. Not all of the new positive ions would be collected, because some, due to aggregation, would have had their mobilities decreased. No consideration has been given to diffusion or recombination, though the magnitude of the latter determines the final values of ion densities in the middle region. Even so, this artifice results in a zero-degree curve remarkably similar to that determined experimentally. The net charge bumps in the middle region are due to pockets of ions of both signs moving back and forth through each other. The form of the distribution in this region is altered by changing either the large cylinder diameter or the applied voltage. Rough calculations of ion mobilities, by following characteristic net charge bumps in this region, yielded 3 to 4 centimeters per second per volt per centimeter, which agrees with precise values of other investigations.

Figure 2. Artificial derivation of net total charge curves

The dotted line is the negative space charge; the light solid line is the positive space charge; the heavy solid line is the net space charge. Arrows show the directions the ions have been moving



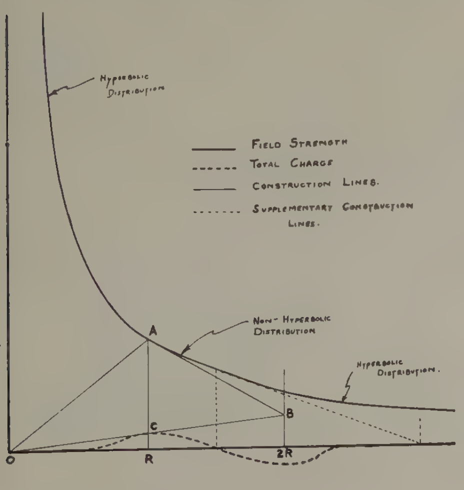


Figure 1. Graphical construction of total charge curve

The abscissa is the radial distance in centimeters, and the ordinate is the field strength and the net total charge in consistent units

Digest of paper 48-201, "The Space Charge Due to Corona," recommended by the AIEE basic sciences committee and approved by the AIEE technical program committee for presentation at the AIEE Pacific general meeting, Spokane, Wash., August 24–27, 1948. Scheduled for publication in AIEE *TRANSACTIONS*, volume 67, 1948.

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Pumping for Power in the Colorado Rockies

FRANK M. WILSON
ASSOCIATE AIEE

THE VAST Colorado–Big Thompson transmountain water diversion project for irrigation and power development has for its operating heart the Granby pumping plant. This plant is of special interest due to its size, its unusual construction, its related storage and diversion facilities, and its key position with respect to a large hydroelectric power development.

The water for diversion will be impounded by the Granby Dam and will be raised by the Granby pumping plant to a canal discharging into Shadow Mountain Reservoir. This reservoir, formed by the Shadow Mountain Dam, will be connected by a short channel to a natural body of water called Grand Lake. The 13.07-mile-long Alva B. Adams Tunnel will carry the water by gravity flow from Grand Lake under the Continental Divide and Rocky Mountain National Park to the eastern slope.

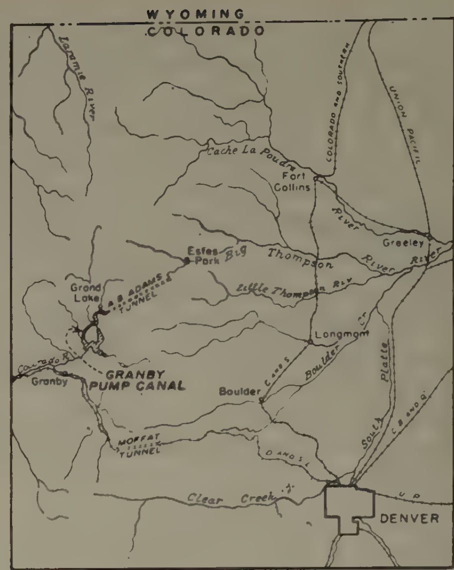
After leaving the east portal of the Alva B. Adams Tunnel, the water will pass through a series of siphons, conduits, tunnels, reservoirs, and a total of seven power plants on its way for use for irrigation purposes. The seven power plants will have a total installed capacity of 154,300 kw and an estimated annual energy generation of 730,000,000 kilowatt-hours.

The combination of natural and man-made features of this project makes pumping for power production feasible by utilizing for hydroelectric power generation the diversion water with its tremendous drop of approximately 2,973 feet after it has been raised in elevation a maximum of 186 feet by the Granby pumping plant. Pumping operations will require only about six per cent of the electric energy which ultimately will be generated by the diversion water.

The 94-foot variation in the inlet head in the Granby Reservoir together with the long suction pipes made it necessary that the pumps be installed below the minimum reservoir level to insure freedom from cavitation throughout the wide operating range. This required that the pump house structure be founded deep in the ground. To resist the high hydrostatic and earth pressures the lower structure of reinforced concrete will consist of a rectangular central section with semicircular ends with the central section having cross walls and beams and massive exterior buttresses.

The pumping plant will be connected by two transmission circuits to insure reliability of power supply since operation of the eastern slope power plants is so closely tied in with pumping operations. To insure operation if one supply circuit is out of service, the pumping plant was designed for two methods of motor starting, namely, full-voltage starting when connected to the normal power system, and reduced-voltage starting when connected to the minimum system.

Figure 1. Map showing location of project where surplus water will be pumped from the western to the eastern slope of the Rocky Mountains



The three pumping units will each consist of a vertical-shaft centrifugal single-stage pump with a capacity of 200 cubic feet per second at the maximum pumping head, driven by a synchronous motor rated at 6,000 horsepower, 327 rpm, 6,600 volts, and 0.95 power factor leading.

Both methods of starting will involve pressure introduction of an oil film between the motor thrust bearing surfaces to lower the necessary starting torque of the motor. The pump discharge valve will be closed for both methods of starting, and the reduced-voltage starting method will require in addition that the water level in the suction tube be depressed by compressed air below the pump impeller.

After the auxiliaries have been put into operation, reduced-voltage starting of a unit will be initiated by a manually operated control switch at either of two stations which will close the reduced-voltage circuit-breaker in the switchgear applying reduced voltage to the motor which will start and accelerate to maximum subsynchronous speed as an induction motor. The motor then will be synchronized at reduced voltage by the automatic application of excitation of the motor field at the optimum conditions of speed and rotor pole angular displacement. The reduced-voltage circuit breaker then will be opened automatically and the full-voltage circuit breaker will be closed automatically to apply full voltage to the motor. Manual operation of a control switch then will introduce water into the pump casing until rated pressure at zero discharge is attained. The pump discharge valve then will be opened by manual operation of a control switch and actual pumping will begin.

The full-voltage starting sequence will be similar except the motor will be thrown on full voltage for starting and synchronizing, and the pump casing will be full of water.

Digest of paper **48-200**, "Pumping for Power in the Colorado Rockies," recommended by the AIEE power generation committee and approved by the AIEE technical program committee for presentation at the AIEE Pacific general meeting, Spokane, Wash., August 24–27, 1948. Scheduled for publication in AIEE *TRANSACTIONS*, volume 67, 1948.

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Experience With High-Frequency Heating

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High-frequency induction and dielectric heating may be applied to many processes, but may not be justified. To study applications, one utility company has established a laboratory and works with customers to meet their needs.

THE Commonwealth Edison Company always has taken an aggressive position in the promotion of new uses of electric power. This is particularly true of high-frequency heating. In co-operation with the Great Lakes Power Club and the Chicago Lighting Institute, the company sponsored one of the first high-frequency heating conferences in January 1945. About 3,000 people attended the 3-day session of talks and all of the well-known manufacturers exhibited equipment. Customer-contact men have brought manufacturers problems into the company's laboratory, and tests have been made on these since the fall of 1943. More than 500 such tests have been made, about 300 of them being induction heating and 200 dielectric heating tests.

It is thought that potential users of high-frequency heating equipment have felt more free to contact the utility company for assistance and advice than to contact a manufacturer of the equipment, for fear of feeling obligated. Demonstrations of the possibilities of this form of heating have been made to other than immediate potential users. Much work has been done and many tests made on jobs which do not appear to be economically justifiable at the moment, but this has no doubt contributed in a large measure to high-frequency heating "consciousness" of customers. In general, the manufacturer is interested principally in those jobs which may develop into immediate sales.

There are six high-frequency generators in the laboratory. The induction heating equipment consists of a 50-kw motor generator set, a 30-kw spark-gap unit, and a 20-kw tube unit. The dielectric heating units consist of a 20-kw and a 3-kw general purpose set and a 1-kw bar sealer. According to standard practice all sets are rated on output capacity except the spark-gap set which is rated on input capacity.

Beside these testing facilities, several equipment manufacturers have laboratories in Chicago and the others can send samples to their factories for processing.

REQUIREMENTS OF SUCCESSFUL APPLICATIONS

From the authors' experience, one or more of the following conditions must be realized before a job ever results in a successful application:

1. Low cost per piece treated.
2. High quality of product.
3. Improved working conditions.
4. Special conditions which make other methods of heating not feasible.

The cost to do a job divides itself into first cost and operating cost. Quite often the first cost of high-frequency heating equipment is higher than the first cost of conventional equipment to do the same job. Since this is true, it is inherently a high production tool. Occasionally, the unique advantages to be attained will justify this higher first cost on lower production rates of relatively valuable items. In order to take full advantage of the speed of high-frequency heating, often rather complex work handling equipment is necessary. In some instances this can be more expensive than the high-frequency generator. Not only is it costly, but the customer usually does not know where to secure it, nor just how it should be designed. Therefore, the manufacturer who can assist in designing or can supply the work handling equipment is finding this to be a very great advantage.

A rule of thumb method of determining the cost of a high-frequency generator is to calculate the power requirements on a pounds per hour, specific heat, and temperature rise basis. From $500 to $1,000 per kilowatt depending on size may be taken as the installation cost. These figures are very approximate, but may help to get some general idea as to the probable cost to set up for a specific job. At least it will indicate whether the problem is worth investigating further.

Shielding is an additional equipment cost which may be necessary, particularly with dielectric heating equipment. The Federal Communications Commission has set up maximum limits of unauthorized radio-frequency radiation in order to protect radio communication channels. Shielding costs may vary from a few dollars to a few hundred dollars, depending on the size and type of equipment.

The speed of high-frequency heating makes it adaptable to continuous operations, and there is not the extra handling which is necessary for batch operations. Uniform quality and high production with a minimum of skilled labor contributes to substantial savings in time and rejects.

On some work such as brazing, in order to meet a certain production rate it may be desirable to heat several pieces simultaneously for a longer time to allow heat flow to equalize temperatures, rather than to heat one piece very rapidly. For surface hardening applications the opposite of course would be true. For jobs well suited to high-frequency heating, any method of work handling will

Full text of a conference paper recommended by the AIEE electronics committee and approved by the AIEE technical program committee for presentation at the AIEE Great Lakes District meeting, Des Moines, Iowa, April 1–3, 1948. Not scheduled for publication in AIEE *TRANSACTIONS*.

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increase production over other heating methods from a limited amount of space.

The outstanding advantage of high-frequency heating is the extremely high power concentrations possible. This is true for both induction and dielectric heating. The induction process allows selective heating because the heat is generated in the work so rapidly that flow by conduction is limited. Inherently, the heat generated by induction is in the surface of the work, this phenomenon being more pronounced at the higher frequencies and higher power concentrations. This allows various treatments not possible by conventional heating methods, such as surface hardening by simple surface heating and different treatment of various parts of the same piece without heating or altering adjacent zones. Once a job is set up, every piece will get exactly the same treatment, thus attaining a degree of uniformity difficult to approach by other heating methods.

Dielectric heating is the only method whereby heat can be generated evenly throughout materials generally considered nonconductors of electricity. These materials are usually poor conductors of heat also. This permits high power concentrations and rapid rates of heating of thick sections not possible by other methods. Where heat must flow to the center of an object by conduction, the rate of rise of the center is limited by the allowable temperature of the surface. Another characteristic of dielectric heating is the fact that some materials heat more rapidly than others. This permits selective heating when the different materials are in layers perpendicular to the plates of the dielectric heater. An excellent example of this is glue line heating in the edge bonding of lumber. This concentrates most of the heat in the glue lines making the entire operation very efficient. By this method it is possible to set the glue in all glue lines of an object as large as a desk top in a minute or less. This is particularly desirable when the glued parts are to be used immediately. They are at practically full strength when removed from the press.

As with most electrically heated devices, working conditions in the immediate vicinity are ideal. No fumes, dirt, or waste heat goes to heating up the room. These better working conditions are definitely valuable in contributing toward satisfied worker relationships.

EXPERIENCE DATA

Table I indicates the number of laboratory tests and installations for various applications of dielectric and induction heating in the company's territory. Included also is the average size of the machines rated on input kilovolt-ampere capacity. This installation record is not complete, but it should be representative and indicates the relative success of high-frequency heating for each type of work.

Dielectric Heating Applications. In the classification of plastics only 37 laboratory tests were made, whereas approximately 70 machines are known to be installed. This includes both heating plastic preforms as well as film sealing. Average size of this equipment is about 8-kva input capacity. This is a rather large average size because it includes some installations, each consisting of a number of large machines, which may not be representative. Heating plastic preforms is particularly well established, being one of the very first dielectric heating applications. The uniform heating all the way through the preform allows lower die pressures, consequently die life is longer and the quality of work is improved. Die closing time and curing time are reduced considerably, permitting higher production schedules. The fact that these advantages are so outstanding no doubt accounts for the large number of installations. In fact, the heating of plastics is the only field that has more machines installed in this territory than the number of laboratory tests that have been made.

In the sealing of plastic films, two types of equipment are available. One is the bar sealer which seals a certain definite line or area at one time by means of dies. The other type employs a scanning technique, progressively heating the film as it passes between two circular electrodes similar to a very small seam welder. Each type has a specific place in industry. The bar sealer is ideally suited to the fabrication of a complete article from several individual pieces in a "one shot" operation. The sewing machine type of film sealer can employ attachments very similar to those of a conventional industrial sewing machine. Therefore it is well suited to such operations as putting a binding or hem around the edge of an article such as a plastic raincoat.

Glue setting, principally in wood, rapidly is becoming one of the more promising applications of dielectric heating. It has been necessary to develop new techniques of handling the work. The electrode design becomes quite complicated in some cases. The electrodes can be arranged for three types of heating: through, stray field, and glue line. Through heating has been used for several years on a very large plywood manufacturing installation. For curing the glue in curved veneer shapes it is very satisfactory and is an economical way of setting this glue when all costs of alternate methods are taken into account. The value of the product in this instance is considerable, and any other method of doing this work is very complicated and laborious. Curing the glue in large items such as frames of grand pianos is economical because of the long storage period necessary when natural drying is used.

Table I. Dielectric and Induction Heating Applications

	Number of Laboratory Tests	Approximate Number of Machines Installed	Average Input Kva
Dielectric			
Plastics	37	70	8
Glue setting	16	8	6
Experimental	3	2	1
Miscellaneous	32	5	2
Dehydration	50		
Infestation	15		
Sterilization	17		
Cooking	17		
Induction			
Brazing	105	40	25
Experimental	4	35	60
Heat treating	82	30	75
Soldering	65	25	10
Glue setting	18	15	2
Degassing	1	15	8
Melting	15	10	275
Forging	19	2	65

By placing bar electrodes of alternate polarity side by side on a flat surface, it is possible to generate heat without getting the electrodes on opposite sides of the work. As yet this electrode arrangement is in limited use. It heats the surface layer of the work and therefore makes some jobs practical which otherwise would not be economical. An example of this is the gluing of thin veneer to a solid or slotted core. Through heating would be slow and costly because of the large bulk of material heated. Further developments and refinements in electrode arrangement and experience data gained on the earlier installations of this type should contribute to many more of these jobs being installed. Small machines of about 1/2-kw output capacity are available having two electrodes side by side at the end of coaxial cable leads. This makes it possible to carry the electrodes to the work, and therefore to do "tacking" or spot gluing. The area that can be cured at one time is limited to a few square inches. In the assembly of small articles these portable machines may save clamps and clamping time by curing the glue almost instantly.

The form of wood gluing which is coming into great popularity today is the assembly of narrow boards into larger sections by the process known as edge bonding. For the plant having sufficient production to justify the initial investment, this method of curing the glue can show huge savings. Economies are possible because of the greatly increased output and the very desirable type of work involved when compared to hand-operated clamps. The high production possible from one of these machines makes it necessary to have fast and efficient glue spreaders as well as air-operated clamps in order to utilize the unit at maximum efficiency.

Setting the glue in cardboard cartons can be done with extreme speed and with very small power input. The work handling equipment is quite complicated, however, and this fact has kept the job from becoming popular.

Because of the lack of knowledge as to which fields were well suited to dielectric heating, 35 tests have been made on experimental and miscellaneous problems. They include a wide variety of work which does not justify individual consideration here.

Dehydration problems have resulted in 50 tests. This is more than any other dielectric application, yet there is no known installation in this territory. The reasons for this naturally divide themselves into two categories. In many instances the product is such that it is damaged by rapid heating. Occasionally this may take the form of cracking because of uneven shrinkage or expansion. At other times damage may be caused by pressure building up when the moisture turns to steam and the product is not porous enough to release the steam rapidly. Of even greater importance than this, however, is the cost of operation. In materials such as laundry, grain, leather, wood, and ceramics, large quantities of moisture are evaporated and conventional methods of drying are practically always cheaper. Since a more economical method is available and usually the product does not have sufficient value to justify additional expense, these fields do not appear promising for future high-frequency heating applications.

Where it is extremely difficult to remove the last few per cent of moisture, dielectric heating may do this economically. Dehydration in the manufacture of the drug penicillin is a good example of an expensive product which justifies the use of a relatively costly heat source in its manufacture. The nature of penicillin is such that it cannot be heated to a high temperature without damage. Therefore, conventional methods of dehydration to reduce the bulk require 24 hours. Dielectric heating has reduced this 24-hour job to 30 minutes.

Weevil infestation is a problem in various materials and 15 tests have been made to kill the weevils and eggs by dielectric heating. The weevils are killed quite economically by fumigation. However, the eggs usually are not killed by this method, and they may hatch later. Where this is important, and where the value has been increased by processing as in packaged cereals, dielectric heating may be the solution. Also, material inside packages is very difficult to treat by any other method. Because of these conditions this application to packages appears more promising than to other infestation problems. Loosely packed fibrous materials probably will heat unevenly and arcing may occur at normal dielectric heating frequencies.

Sterilization as used here refers to the killing of bacteria and fungi. Although considerable interest has been shown by customers who have brought in 17 of these problems, no positive results were obtained.

Cooking, dehydration, infestation, and defrosting are problems common to food processing. Dehydration and killing of infestation usually can be done by cheaper methods and certainly this is true of defrosting frozen food. Cooking does not work very well at conventional dielectric heating frequencies because most food is not homogeneous and therefore heats unevenly. The "Radarange," which operates in the 2,450-megacycle range of frequency, is not so selective and for example will heat fat and lean meat quite uniformly. Phenomenal heating rates are possible, such as cooking a steak in 45 seconds and similar extremely short cooking times. The cooking done is equivalent to boiling, and auxiliary equipment is necessary to give a steak the familiar "browned" appearance. At this very high frequency the difficulty of arcing, which occurs when heating very fibrous material at lower frequencies, is not a problem. This may open up many new fields when rugged higher frequency equipment is available. At present the Radarange is leased to eating places. Another new type of processing equipment is the sandwich heater announced some time ago by a food vending concern. Operating at 70 megacycles, it heats the sandwich inside a transparent Cellophane bag and delivers a hot sandwich a fraction of a minute after the coins are inserted.

Induction Heating Applications. Brazing has been the most popular application of induction heating with 105 tests and about 40 installations. The localized heating has great advantages and permits economies in this field. Other applications are shown in the table.

Heat treating has been a particularly active field. The localized heating at extremely rapid rates assists in getting heat patterns not attainable in any other way. In order to get these rapid heating rates, a large amount of power is necessary.

Glue setting by induction may sound odd. The job involved usually is cementing loud-speaker cones to the metal framework. The supporting framework is heated inductively which sets the thermal acting glue used.

Degassing of metallic elements in vacuum tubes is an old and successful application with about 15 installations.

Melting with induction equipment offers many advantages, particularly where controlled quality and purity of the melt is important. Very large equipment is in use for this purpose, as well as smaller sizes for melting a few pounds of metal at a time.

Forging is a field to which induction heating offers many advantages. Substantial savings can be realized in longer die life and savings of material. High production rates and improved working conditions are other advantages. In spite of the possible benefits from induction heating in this field, only two installations are known, probably because of the type of industry served.

It is apparent that in some types of applications much interest has been displayed by customers as evidenced by the number of tests, but relatively few installations actually have been made. Some of the reasons for this are believed to be

1. Some products are of such a shape that the area to be heated does not lend itself readily to getting electrodes or coils in the proper location.

2. Too low production of an item makes it difficult to justify the first cost. This is particularly true if the job requires large amounts of power for short periods of time. Most jobs are not too big, if there is enough work to keep a machine busy.

3. On high production items which may lend themselves readily to high-frequency heating, if the value of the product or the margin of profit is too low, it may not justify the cost of high-frequency treatment.

4. On good applications where the customer could produce his item cheaper by using high-frequency heating, there may be a resistance to change and a slowness to accept new methods.

5. Due to large postwar expansion in the field force, all the contact men are not yet thoroughly educated to recognize good or poor potential jobs when they see them. This has resulted in some poor applications being tested.

FACTORS TO BE CONSIDERED

These experiences with high-frequency heating may be of value to present and prospective industrial users. Attention is called especially to the following points:

1. High-frequency heating today is rather expensive and usually can be justified only by high production.

2. Work handling equipment is

(*a*). Quite important to the application.
(*b*). Expensive.
(*c*). Often hard to procure.

In spite of some difficulties, it is believed that high-frequency heating will aid industry in its continual search for better goods for more people at lower cost.

Transformers for Brazil

Sixteen identical water-cooled power transformers being assembled at the General Electric factory in Pittsfield, Mass. The transformers are rated single phase, 1,250 kva, 60 cycles, 44,000 to 2,300 volts. They are part of the modernization program of the Cia Docas Santos, and will be used in a main substation in Sao Paulo, Brazil. Each transformer will be installed in a separate cell and will be cooled by an existing water supply

Polarity of D-C Control

AN AIEE COMMITTEE REPORT

Polarity of device coil connections is important in preventing coil corrosion. Replies to AIEE questionnaires indicated that there was no trouble resulting from coil corrosion where the negative connection was used, while more than 50 per cent of the companies using the positive connection reported corrosion trouble. As a result of this report, the AIEE Standards committee took action as reported in *ELECTRICAL ENGINEERING*, December 1947, page 1250.

THE standardization of polarity of d-c control is important not only from the standpoint of the advantages of standardization in itself, but particularly so when serious trouble may be avoided by adopting the correct standard practice.

Recently a working group, initiated by the AIEE substations committee (previously the AIEE automatic stations committee), conducted a survey of representative operating companies and manufacturers throughout the United States. The purpose of this survey was to find out what their experiences have been and what their present practices are. The questionnaires forwarded to representative operating companies consisted of the following queries:

1. What practice does your company follow when connecting the station battery to control coils and reason for such practice?
2. Have you always followed the same practice—if not, when and reasons for change?
3. If the positive polarity of the station battery is connected to control coils have you experienced any trouble with corrosion due to electrolytic action?
4. If the negative polarity of the station battery is connected to control coils, have you experienced any trouble with corrosion?
5. Would your company follow a standard if adopted by AIEE?
6. Any additional information that you consider will assist the working group on polarity of d-c control in arriving at a definite conclusion.

A similar questionnaire was sent to representative manufacturers. A summary of all replies shows that

Twenty-five companies now are using the negative polarity connection. Seven companies now are using the positive polarity connection. However, one of these reported considerable corrosion and expects to change to the negative polarity connection in the near future.

Five companies now are using both connections.

Eight companies have changed from the positive polarity connection to the negative polarity connection because of corrosion difficulties.

One company changed to the negative polarity connection after a report on corrosion appeared in *Relaying News*. Another company, while experiencing no corrosion difficulties with the positive polarity, changed in order to conform with its understanding of modern practice.

Seventeen companies who are using or have used the positive polarity connection reported corrosion troubles, while 15 in the same classification attributed no corrosion difficulties to the positive polarity connection. However, two of the latter 15 companies reported the use of heaters in housings and cubicles.

No cases of corrosion were attributed to the negative polarity connection.

A substantial majority indicated that they would follow a standard if adopted by AIEE.

Two manufacturers prefer the negative polarity connection while the third failed to state his preference.

The results indicate that by connecting various control coils to the negative polarity of the station battery, corrosion by electrolytic action is reduced to a minimum. This is substantiated further by technical papers[1–8] and by one manufacturer and a chemical engineer.

The manufacturer stated,

"The problem of coil corrosion which we meet is an electrolysis phenomenon due primarily to condensation of moisture on the coils in outdoor equipments, such as trip coils of outdoor circuit breakers. To prevent condensation causing electrolytic corrosion requires that whatever coil treatment is used hermetically seal the coil. When the condensation occurs on the surface of the material, it rapidly absorbs CO_2 and other impurities from the surrounding air, forming an electrolyte such as H_2CO_3. With 125 d-c control voltage, we are in the range of very high voltages for electrolysis. Current flows through the electrolyte across the coil surface to the grounded coil frame through some infinitesimal crack in the coil insulation to some one coil wire. From the grounded coil frame it returns through the ground to the midpoint of the usual ground detecting means on the station control battery, usually a couple of 10-watt lamps, or two d-c voltmeters with the midpoint grounded."

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Personnel of working group: J. H. Vivian (M '40) Southern California Edison Company, Ltd., Los Angeles, Calif., *chairman;* I. T. Knight (M '42) Kansas City Power and Light Company, Kansas City, Mo.; T. R. Halman (M '43) The Detroit Edison Company, Detroit, Mich.; V. E. McCallum (M '38) Commonwealth Edison Company, Chicago, Ill.; J. M. Flanigen (M '25) Georgia Power Company, Atlanta, Ga.; K. N. Reardon (M '45) West Penn Power Company, Pittsburgh, Pa.; D. M. MacGregor (A '37) Ebasco Services, New York, N. Y.; J. H. Neher (M '38) Philadelphia Electric Company, Philadelphia, Pa.

Joints and Clamps for Aluminum Conductors

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PROBLEMS confront every electrical utility in maintaining existing connections in electric conductors, and in selecting from the many designs and materials available for new construction. Good mechanical characteristics of conductor joints and clamps can be assured by careful attention to design, selection of materials, and workmanship. The attainment of good and lasting electrical characteristics is evidently more difficult because most failures have been attributed to poor electrical conductivity. On an industry-wide basis, this problem warrants extensive research.

Aluminum as a conductor material now predominates in several countries, and finds increasing application in others. The special problems of aluminum-aluminum and aluminum-copper connections therefore require increasing attention to ensure lasting conductivity and freedom from galvanic corrosion. Predictions of long-term performance of such connections from the results of accelerated life tests are not convincing. A better basis is to be found in past experience, supplemented by long-term life tests under controlled, but not highly accelerated conditions.

Three such long-term exposure tests* have been made on live-line tap clamps, U-bolt clamp connections between aluminum-cable steel-reinforced (ACSR) and copper cable, and various types of sleeve joints in ACSR. During the exposure periods of 5 to 7 years, the joints were subjected to a load cycle and, periodically, measurements of electrical resistance were made. Following the exposure, some specimens were examined for corrosion, and subjected to heat runs and short-circuit current tests.

Live-line tap clamps of the screw type maintained much lower resistances than spring-type. This is attributed to the higher contact pressure of the screw-type clamps. Uncoated bronze clamps caused serious corrosion of ACSR strands. Coatings of zinc and tin on bronze clamps lessened corrosion of the ACSR strands but did not appreciably affect resistance values. On completion of the 5-year exposure, almost all of the zinc coating had disappeared in the contact area, whereas the tin coating was intact. Preferred materials for the contact surfaces of live-line tap clamps connected to aluminum cable are, then, aluminum and tinned bronze. Serious binding of threads in all-aluminum screw clamps was observed after exposure.

In U-bolt clamps also, serious corrosion of ACSR strands occurred where they contacted clamp parts of copper but the relatively massive aluminum clamps suffered no serious damage due to contact with copper cable. Coatings of zinc or cadmium on copper clamps lessened galvanic corrosion, but during the 5-year exposure, electrical resistivity of such coated clamps increased to the point where serious burning of the ACSR strands occurred.

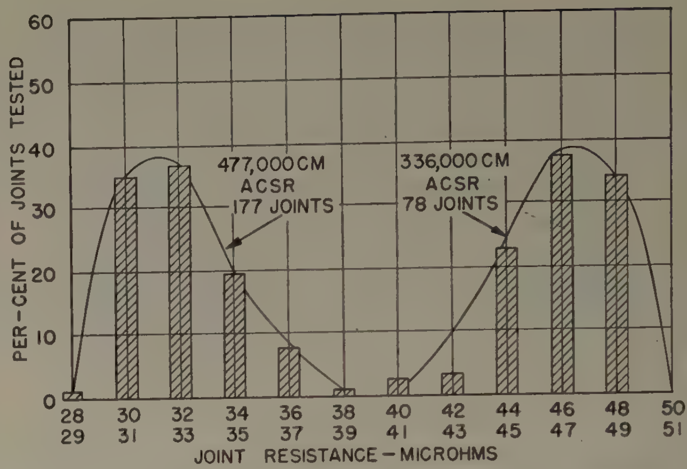

Figure 1. Distribution of joint resistances measured during line construction

Consistently low resistance values are attributed to design of extruded tubing sleeve, adequate cleaning procedure, and proper compression. Sleeves for both 477,000-circular-mil ACSR and 336,000-circular-mil ACSR are approximately 25 inches long. Resistances of equivalent lengths of each conductor are 77 and 110 microhms, respectively

Of the aluminum, copper, zinc, and cadmium separators tested between copper cable and ACSR, those of aluminum maintained the lowest resistances to the ACSR. Resistance of all separators to the copper cable remained low throughout the test. Coating the contact surfaces with a corrosion-inhibiting petroleum grease lessened corrosion, especially where dissimilar metals were in contact, but did not maintain appreciably lower resistances. For the clamps coated with zinc or cadmium, petroleum grease appeared to increase resistance values.

Hydraulically compressed sleeve joints in ACSR were found to possess lower and more stable resistances than those pressed with light hand tools or twisted sleeve joints. The resistance of twisted sleeve joints was affected more than compression joints by variations in type of filler.

The result of improved jointing techniques is illustrated in Figure 1 by an analysis of resistance values on some 250 compression joints in ACSR measured during construction of high-voltage lines. Maximum joint resistance is less than half that of an equal length of conductor and, for each conductor size, the maximum deviation from average value is less than 15 per cent. The consistently low resistance values obtained in these field tests indicate, of course, good workmanship, but also provide assurance of long life when related to the results of exposure tests.

Digest of paper 48-202, "Joints and Clamps for Aluminum Conductors," recommended by the AIEE transmission and distribution committee and approved by the AIEE technical program committee for presentation at the AIEE Pacific general meeting, Spokane, Wash., August 24–27, 1948. Scheduled for publication AIEE *TRANSACTIONS*, volume 67, 1948.

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The "Linascope" Fault Locator

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ASSOCIATE AIEE

THE INSPECTION of circuits by pulse reflection methods is well known to communications engineers. In particular this technique has been used in inspecting high-frequency coaxial telephone and television lines. The "Linascope" is an electronic instrument for locating faults on open-wire telephone and transmission lines. The unit generates repetitively a short duration pulse which is fed to the circuit under test. The pulse travels along the line at a speed nearly equal to that of light (186 miles per millisecond). Echoes arise from faults, junctions, terminations, and other impedance irregularities, and return to the Linascope terminals at the same speed.

The transmitted pulse and returning echoes are displayed on a linear time base on a cathode ray tube. Thus, distances along the cathode-ray tube sweep are directly proportional to distances along the line. Sweep speeds are provided corresponding to line lengths of 50, 100, 200, and 300 miles. Distances are measured accurately by means of a "strobe" or range-finder circuit. By means of the range finder potentiometer which is calibrated in miles, a dark spot on the cathode ray sweep is moved until it aligns with the fault echo. Distances readily are determined to within half a mile on the 100-mile scale.

At an open-circuit fault the echo is of the same magnitude and polarity as the incident wave. At a short-circuit fault the echo is again of the same magnitude but is reversed in polarity. If the line is terminated in its characteristic impedance there is no reflection from the termination. In general, if the pulse is incident upon an impedance greater than that through which it is passing, an echo arises of the same polarity. If the pulse is incident upon an impedance lower than that through which it is passing, then an echo of reversed polarity occurs.

The Linascope has been used on open-wire telephone circuits for the location of various fault conditions including open and short circuits and high resistance joints. Incipient faults have been located before they caused an interruption to telephone communication.

Tests have been performed on high-voltage lines which were removed from service for the purpose. Artificial faults at distances as great as 300 miles have been detected on a 220-kv circuit. Transposition points give slight echoes and the limitation to the convenient use of the instrument is reached when the fault echo is of the same order of magnitude as the transposition echoes. Tests have shown this condition to arise for a phase-to-ground or phase-to-phase fault when the fault resistance rises to 10,000 ohms.

A unidirectional pulse was used in the early tests, but more recently a short-duration high-frequency wave burst has been utilized where connection to a transmission line (alive or out of service) through a tuned high-voltage coupling capacitor is desired. A wave-burst Linascope now has been installed at the Leaside transformer station of the Hydro-Electric Power Commission of Ontario. In its present form, it is suitable for locating sustained faults on any of the four 220-kv circuits entering the station.

Figure 1. Linascope installed in the Leaside transformer station of the Hydro-Electric Power Commission of Ontario

It is hoped that eventually it will be possible to adapt this unit to record transient faults. Preliminary tests performed on a live 110-kv line indicate that echoes from bus structures are visible. An automatic recording device has been developed for use with the unit.

No tests have been made with the unit on distribution networks as yet. Most distribution networks have so many interconnections that the echo pattern will be quite complicated. It probably would be proved necessary to have a chart of the circuit under normal conditions, with which the pattern under the faulted conditions can be compared. Even then, the possibility of several paths of the same length will have to be considered. It is doubtful, too, that these units can be made available in sufficient quantities within a power company, for use as a routine maintenance instrument on distribution circuits.

Digest of paper **48-207**, "The 'Linascope'—An Echo-Ranging-Type Fault Locator for High-Voltage Lines," recommended by the AIEE transmission and distribution committee and approved by the AIEE technical program committee for presentation at the AIEE Pacific general meeting, Spokane, Wash., August 24–27, 1948. Scheduled for publication in AIEE *TRANSACTIONS*, volume 67, 1948.

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Mathematics for Engineers—I

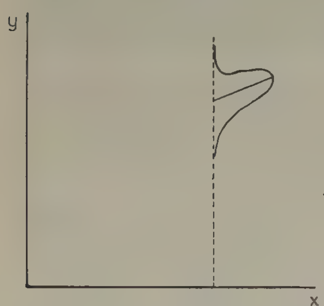
Fitting Functions to Engineering Data

EDWIN G. OLDS FORMAN S. ACTON

Increasing interest of electrical engineers in mathematics has stimulated conferences on the subject at recent AIEE meetings. Presentations made during the 1948 winter general meeting have led to the preparation of a 3-part series, which will be made available in pamphlet form following its completion in ELECTRICAL ENGINEERING. In this first part of the series, reasons and methods for fitting functions to data are outlined and the degree of confidence that may placed in data is discussed. Subsequent parts of the series will discuss the method of Graeco-Latin squares and the dimensional analysis of partial differential equations.

THE INTEREST of electrical engineers in mathematics has increased steadily ever since electrical engieering became a science. This interest is proper because mathematics has proved to be a forceful tool in the solution of many engineering problems.

In recognition of this interest and for the further promotion of the use of mathematics in electrical engineering, the AIEE basic sciences committee established a subcommittee on mathematics which arranged for two conferences on applied mathematics. The first was held during the 1947 winter meeting and dealt with such varied topics as computing machines, probability, and hydrodynamics. The speakers included Doctor John Von Neumann of the Institute of Advanced Study, Princeton, N. J.; Doctor Garrett Birkhoff of Harvard University, Cambridge, Mass.; Doctor Mark Kac of Cornell University, Ithaca, N. Y.; and Charles Concordia of the General Electric Company, Schenectady,



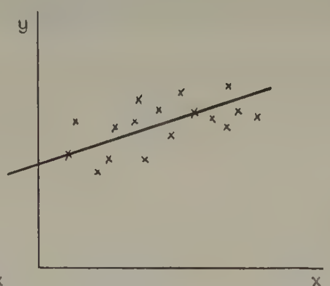


Figure 1 (left). Distribution of y for a fixed value of one independent variable x

Figure 2 (right). Distribution of y for different values of x

N. Y. The topics were very ably presented and the interest of the audience was attested by the large number who attended and by the participation of the audience in the discussion. It was, however, apparent to the committee that the conference lacked unity of thought because of the wide variety of topics.

The second conference, held during the 1948 winter general meeting in Pittsburgh, Pa., aimed at unity of thought. The general topic was "What the Engineer Can Do With His Data." This topic was attacked from several points of view. Again the interest of the audience surpassed expectations. By a unanimous vote, those in attendance voted to have the papers published for distribution. Topics and authors were

"Fitting Functions to Engineering Data," by Edwin G. Olds and Forman S. Acton of the Carnegie Institute of Technology.

"Method of the Graeco-Latin Squares," by H. Poritsky of the General Electric Company.

"Dimensional Analysis of Partial Differential Equations," by Garrett Birkhoff of Harvard University.

It is the committee's hope that the material presented in this series will be found useful. Indeed, no engineer can afford to be uninformed on the proper handling of experimental data.

Section *A**

It is the authors' object to examine the philosophy of fitting functions to engineering data: the assumptions usually made, the information preserved or lost, and—in broad outline only—the methods available. There are many articles which give the mechanics of fitting functions, but here a broader viewpoint will be taken in order to straighten out some existing misconceptions, reveal certain concealed implications, and point out where some current efforts are being wasted unnecessarily. Many topics must be slighted in order to keep this treatment brief.

The engineering data being considered might be represented by results of tests on a piece of equipment in which several independent variables were varied over their several values and some one dependent variable was measured and recorded. The equipment tested might be a unique piece, say a transformer for a power system, the data forming a record of its performance for future use by the purchaser, or it might be some "typical" units of a mass produced item such as a line transformer, in which case the records would be used to show, in some sense, an "average performance."

Edwin G. Olds is an associate professor and **Forman S. Acton** is a graduate assistant in the department of mathematics of the Carnegie Institute of Technology, Pittsburgh, Pa.

Acknowledgment is made of the assistance of Michel G. Malti (M '45) professor of electrical engineering, Cornell University, Ithaca, N. Y., who prepared the introductory remarks.

* Prepared by Forman S. Acton.

Before any discussion of how to fit functions reasonably can be undertaken, it is necessary to consider *why* an engineer fits functions to his data. There are three basic reasons:

1. To condense his data to an equation or graph for easy remembering and use for prediction.
2. To allow interpolation between experimentally measured values.
3. To smooth the data.

Perhaps it should be remarked that an engineer rarely is interested in a concise record of past performance for its own sake. He wants that past record as a basis for predicting the future. He may not assume safely that the future will be identical with the past, although this assumption frequently is implied in technical reports, but rather he must assume that the past will give an average performance about which, in the absence of further information, the future may be expected to oscillate. The use of fitted functions for condensation and interpolation are recognized universally, the third use needs amplification. If a function is fitted to data, and if it is a good fit, then a value estimated from the function may be, in some sense, a better value than an actual experimental reading taken at that point. This seems peculiar until one reflects that the experiment may not be very precise and that a single reading may be considerably in error, whereas a value predicted from a curve (function) has many experiments contributing to its accuracy. A fitted function, then, brings to bear *some* information from *all* the experimental measurements, a situation which in general is more accurate than is taking *all* the information from *one* experimental measurement.

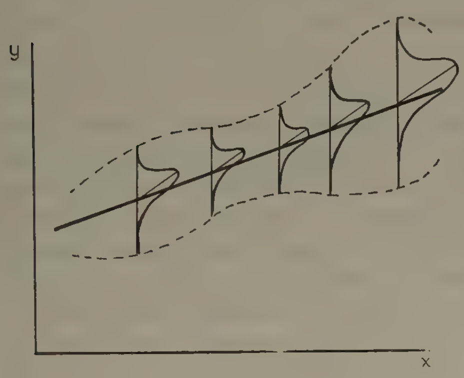


Figure 3. Example of frequency distributions for five values of x

The fitting of functions, then, is motivated by the knowledge that all data are in error, be that error large or small, and by the desire to reduce that error, to get behind the smoke screen which that error throws up, back to the underlying "reality." This is a noble motivation, but it is futile. Error plays a defense-in-depth game. There are many sources of error, and no matter what precise physical laws one sets up, no equipment ever will obey them because some of this "error" is really part of the performance of the equipment, and is considered error by the engineer only because he cannot predict behavior with precision by classical mechanics. The several sources of error in the results of an experiment may be classified as

1. Uncontrolled variables (random or systematic—if they are not controlled, they will wobble and introduce variations in the answers which will be interpreted as error). These uncontrolled variables may vary within one piece of equipment or one set of experiments, or may occur between two so-called "similar pieces" of equipment.
2. Accuracy of measurement. This may be caused by uncontrolled variables in the measuring equipment, or other causes—but they are listed as distinct from causes inherent in the equipment being tested. This error is the part of the smoke screen it is desired to strip away.
3. Inadequacy of formulas used in fitting the data.
4. Computational errors (usually negligible in fitting engineering functions).

All these remarks are about past data, and the picture is rather complicated. When one considers, however, that these data are to be condensed and used as a prediction of future performance, still other complications are added. The uncontrolled variables might wander over a wider range in the future, or the present equipment may deteriorate and hence present performance may not be "typical"—to mention only two of the many difficulties. This is, however, an engineering, not a mathematical problem. The mathematician only may point out the necessity for the data collected to be typical; he may insist that the engineer face the fact that his experiments are shot full of error of several definite types; but it remains for the engineer to plan his experiments so as to avoid being trapped by these difficulties. If he pretends he has precision, he is in for trouble; if he admits the presence of error and treats it statistically, the results may almost be pleasant.

In the previous paragraph, the word "typical" has been bandied about in a loose sort of fashion which well might disturb an engineer (let alone a mathematician) who faced these problems. Unfortunately, no precise way is known to nail down all the ideas which are implied by this term. Engineering judgment always will be required to decide just how "typical" any piece of equipment which was made or tested today will be of equipment to be made or tested tomorrow, or next year. One device which will help in this decision, however, is the familiar control chart. If routine test data on pieces of equipment show that a state of control exists, then the engineer may be much more confident that his data are "typical" for that group of experiments or type of equipment.

In general there will be two questions to which answers are wanted:

1. How good is the fit of this function to the data now available?
2. How good a predictor is this function?

Suppose repeated measurements are made of a dependent variable while the independent variables are held fixed. Because of some variables which are not or cannot be controlled (and for other reasons discussed previously) one will obtain a set of numbers, not all alike, which usually will be distributed about some central value and, with luck, these values will be approximately normal or Gaussian. In general, the better the experiment is planned and controlled, the more nearly normal the uncontrolled residual variation is apt to be. This is pleasant, since the normal distribution is one of the few frequency distributions that statisticians really feel they understand—so an increase of experimental precision pays off in a still greater increase in information extractable from the data. This is,

however, a 2-edged sword; rough data frequently yield results for which satisfactory tests of significance are not available, because of the experimenter's inability to assume normality.

If there is only one independent variable x, the distribution of y for a fixed value of x may be indicated on a graph by a perspective sketch of the distribution, as in Figure 1. The width of this distribution may be relatively small, as in the measurement of the resistance of a coil of wire, or it may be large, as, say, the current being passed by an unstable circuit.

If y is a function of x, several readings usually may be taken at different values of x. The results are shown in Figure 2. This is not, however, the whole story. There is really a distribution in y for each value of x. If, say, five values of x had been chosen and 30 measurements of y at each of these five values had been made, then frequency distributions could be constructed which might look like Figure 3. This rather complete and expensive experiment could be summarized by three lines: the line through the centers of the distributions, and the two border lines which include some arbitrary percentage (95 per cent) of the observations at each point.

All data are expensive, so one buys as few as possible. All data are variable, hence as many as possible are needed. The economic balance to be struck here is frequently a nice one. The complete picture of Figure 3 is too expensive, but many of its advantages may be retained in a cheaper model if one is willing to make some assumptions which are frequently reasonable. The common assumptions are

1. That the distribution at any fixed value of x is normal.
2. That the width (standard deviation) of this distribution is constant with x, that is, that only the mean of the distribution shifts with x.

These assumptions are not the only tractable ones, nor are they always fulfilled, but if they are fulfilled, then it is possible to reduce drastically the number of data needed to yield a useful function. Most least squares techniques currently used by engineers and set forth in respectable statistical texts make these assumptions, whether or not they state them explicitly. These techniques, at least those in statistical texts, not only fit the best straight line (or parabola, or other previously specified function) to the data at hand, but they also give an estimate of the (constant) width of the band analogous to the one in Figure 3. This band usually is called an error band or interval, and can be interpreted as the region in which some arbitrary percentage of the experimental points have fallen.

When an array of data is presented for condensation, the functional form may be specified by a theory, by previous experiment or experience, or it may not be specified at all. If the functional form is to be chosen from examination of the data, then it is usually easiest for most people to plot the data and look at the trend of the points. This is satisfactory if there is only one independent variable, x, but it gives trouble if there are two, and it becomes very difficult indeed if there are more than two. There just are not enough dimensions. The rest of this section will be limited to two independent variables, x_1 and x_2, because perspective graphs can be drawn to illustrate the remarks, although in practice one rarely would draw a perspective graph to solve any problem of function fitting.

If the data are taken at intersections of a grid in the x_1, x_2 plane, it is fortunate indeed, for then the data y versus x_1 may be plotted at the several levels of x_2 and, correspondingly, y versus x_2 plotted at several values of x_1. This is equivalent to slicing the 3-dimensional surface perpendicular to one axis, and seeing what the slices look like, edge on. Here the slices perpendicular to x_1 are parabolas while the slices perpendicular to x_2 are straight lines (Figure 4). If a plot of the data revealed this structure, then one would be tempted to fit a function of the form

$$y=a(b-x_1)(x_2-c)^2$$

as this has the required properties when one replaces either x_1 or x_2 by a constant. It is not necessary, of course, to plot the 3-dimensional figure to get this information; merely plots of y versus x_1 and y versus x_2 will suffice.

If the data were not taken by such a considerate experimenter, however, the job becomes more difficult. It is sometimes possible to force the data into an artificial grid—plotting y versus x_1 for several points which *almost* have the same values of x_2. As the object of the plotting is to get a rough idea of the shape of the surface as a cue to the type of functional form which might fit well, the plot can be rather rough and still serve its prognostic purpose.

Once the functional form has been chosen, or if it was specified from other sources, there remains the problem of evaluating the constants. This may be done by multiple regression (least squares) techniques. Deming's book "Statistical Adjustment of Data" gives a rather complete treatment of this subject for the engineer, but it should not be approached as light reading—it is not. The regression technique can be employed blindly, without functional forms even when the data are not on a grid. This means merely evaluating the coefficients of a general power series in the independent variables. It is laborious, it is inefficient, but is sometimes almost necessary because the experimenter cut corners and the cuts are paid for here. In general it is not to be recommended!

The regression computations are tedious, although a good electric desk calculator can reduce the labor considerably. These computations yield coefficients in algebraic equations which summarize the data, and also yield a measure of how well the function fits the data—the measure being a sort of average deviation of the actual data from the fitted surface. There is, however, another technique which is primarily graphical. The computations are largely graphical, and the end result is a set of graphs which give the cross sections of the fitted surface. No functional form need be assumed (an advantage) and the labor is perhaps no worse than the other computational techniques, but no measure of final residual dispersion comes out of the graphs; it must be computed separately, afterwards. That measure is important; it always should be calculated and presented with the function, lest other people believe the fitted function to be better than it really is. This graphical technique is described in Ezekiel's "Methods of Correlation Analysis."

One unfortunate habit seems to persist in many labora-

tories. If the relation between a dependent variable and a series of n independent variables is to be investigated, there is a strong tendency to hold $n-1$ variables fixed at one set of values while varying the n'th. This process is repeated with each of the n variables and then the experiments are stopped. Each variable has been investigated—what more could be desired? If the variables are truly independent in their effects on the dependent variable then, of course, nothing more is necessary; but this is the exception rather than the rule. In the case of two independent variables, this procedure means the more or less accurate determination of two lines (see Figure 5), from which the rest of the functional surface is to be inferred. When put in this light, the fallacy of the procedure becomes apparent. For a complete picture of the dependence of y on x_1 and x_2, experimental values are needed over the entire grid in the x_1, x_2 plane where it is desired to know the functional form—not just along two lines. The extension of the arguments and requirements to n dimensions is both obvious and valid. The number of experiments goes up exponentially with the number of independent variables, an assertion which is economically unpleasant, but unfortunately true.

Section *B* *

In the foregoing section of this article some of the reasons have been given why engineers want to fit functions to data and the methods available have been indicated, together with their limitations. It was noted that there are two questions for which the engineer needs an answer:

1. How good is the fit of the function to the data used for fitting?
2. How good a predictor is this function?

How precisely the first question can be answered depends, as noted, on the methods used for fitting and will not be discussed further. The second question, however, deserves more consideration, and this section contains additional remarks on prediction. (Unfortunately, perhaps, these remarks include a few formulas and some technical jargon. However, the usefulness of the methods will more than compensate the reader for the unhappiness of ploughing through some unfamiliar ground.)

As a first problem, suppose it is wanted to estimate the mean value M of a dependent variable y when all independent variables known to affect y are held at some fixed values. In spite of efforts to the contrary, there usually will be some variation in y. Therefore the exact determination of the true mean value would require information regarding the relative frequency of occurrence of all possible values of y and is an unattainable goal except in theory. However, an estimate of the true mean may be obtained by taking n independent observations on y and averaging the results. In other words, $y_{avg}=\Sigma y/n$ provides an estimate of M.** From a second sample of n observations there usually would be obtained another value of y_{avg} and, therefore, another estimate of M; and so on, sample by sample.

Suppose that for one particular sample of n values of y it is found that y_{avg} is equal to some value Y. Then, on the basis of this one sample, M would be estimated to be Y. How good is this particular estimate? One never can be sure, but it should be known how to place a bet on it if the result is to be used as a basis for action. The bet is not on the exact value of M but rather on what interval contains it. With M estimated to be Y one does not bet that M is Y but rather that M is between $Y-d$ and $Y+d$. The bets may be 9 to 1, or 19 to 1, or 997 to 3 where the odds would signify, respectively, 90 per cent confidence, 95 per cent confidence, or 99.73 per cent confidence. For a fair bet there must be a way of fixing the proper interval. Each time we make such a bet we win or lose, but we want to break even, on the average, in a long series of bets.

The distribution of y is not known but commonly is assumed to be Gaussian. The Gaussian (normal) distribution has two constants: M, the mean; and σ, the standard deviation (a measure of spread). Even if y, itself, is not Gaussian, the theoretical distribution for y_{avg}, in repeated samples of size n, has the same mean M and a standard deviation $\sigma/\sqrt{n}$. Usually it is almost Gaussian.

If y_{avg} is assumed to have a normal distribution with mean M and standard deviation $\sigma/\sqrt{n}$, then

$$u=(y_{avg}-M)\,/\frac{\sigma}{\sqrt{n}}$$

has a normal distribution with mean, 0, and standard deviation, 1. If M and σ are known (or assumed) then the probability that y_{avg} will be greater than K (any arbitrary number) is equal to the probability that u will be greater than $(K-M)/(\sigma/\sqrt{n})$, which usually is written

$$\text{Prob. } (y_{avg} > K) = \text{prob.}\left(u > \frac{\sqrt{n}(K-M)}{\sigma}\right)$$

The value of this probability can be read from a table of the normal integral. For example, the probability of a value of y_{avg} exceeding the mean of all of the y_{avg}'s by more than 1.96 times the standard deviation of y_{avg} is the same as the probability of getting a u value greater than 1.96. From the table of the normal integral the latter probability (and, therefore, the former) is found to be 0.025.

If the standard deviation for the theoretical distribution of y is known a 95 per cent confidence interval can be calculated for the unknown mean M by the following procedure: Calculate M_1 so that if the true mean were M_1

$$\text{Prob.}(y_{avg} > Y)=0.025 \text{ (see Figure 6)}$$

Also calculate M_2 so that if the true mean were M_2

$$\text{Prob. } (y_{avg} < y)=0.025$$

There are obtained

$$M_1=Y-\frac{1.96}{\sqrt{n}},\quad M_2=Y+\frac{1.96}{\sqrt{n}}$$

Then the interval, M_1 to M_2, is called the 95 per cent confidence interval for M. In other words the betting odds are 19:1 that the unknown mean M has a value between M_1 and M_2 as calculated here. For a shorter interval either the size of the sample must be increased or the odds decreased. A 90 per cent confidence interval, for example, is enclosed

* Prepared by Edwin G. Olds.

** Throughout this paper y_{avg} is used to denote the arithmetic mean or average of a set of y-values while x mean is used to denote the arithmetic mean or average of a set of x-values. Obviously the subscripts are interchangeable.

by $Y \pm U_{0.05}(\sigma/\sqrt{n})$ where $U_{0.05}$ means prob. $(u > U_{0.05}) = 0.05$.

When σ is not known it must be estimated from the sample. This estimate, denoted by s, is obtained from the formula

$$s^2 = \frac{1}{n-1}\sum_{i=1}^{n} (y_i - y_{avg})^2$$

(It is interesting to note that minimizing $\sum_{i=1}^{n}(y_i - a)^2$ with respect to a gives $a = y_{avg}$ and $\Sigma(y - y_{avg})^2$ as the minimum sum.) If, in the formula,

$$u = \frac{\sqrt{n}(y_{avg} - M)}{\sigma}$$

we replace u by t and σ by s, the variable t defined by the resulting formula

$$t = \frac{\sqrt{n}(y_{avg} - M)}{s}$$

no longer has a normal distribution like the u distribution. It has fatter tails than the normal distribution so $t_{0.025} > u_{0.025}$, where prob. $(t > t_{0.025}) = 0.025$. For example, corresponding to $n-1 = 1, 2, 3, 4$ we have $t_{0.025} = 12.71, 4.30, 3.18, 2.78$. As n tends to infinity $t_{0.025}$ tends to $u_{0.025}(=1.96)$.

Since the distribution of t is tabled, it can be used conveniently to aid in constructing confidence intervals for M in case σ is not known. For example, the 95 per cent confidence limits for M, on the basis of the evidence of a sample of size n, are

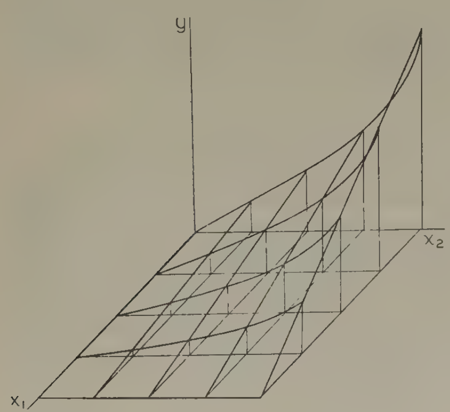


Figure 4. Example of perspective graph

$$Y \pm t_{0.025}\frac{s}{\sqrt{n}}$$

The status quo is represented by $Y = y_{avg}$. How can it be maintained? If, for a particular process, the estimated level is satisfactory, one method of keeping stability is to use a Shewhart control chart. Take new sets of y values at intervals, plotting the mean and range for each sample and applying control limits as directed in the American Standards Association manual on "Control Chart Method of Controlling Quality During Production." If a state of control seems to exist the whole lot of samples may be thrown together and the estimates of M and of σ improved.

If M seems to be changing, or if it is desired to change it, we need theory to tell us what variables influence y. Suppose we assume that a linear relation of the form,

$$M = \alpha + \beta(x - x_{mean})$$

connects the mean value of y with x. Suppose, further, that we have recorded values of y for n values of x. For any particular value of x, say x_1, we want the true mean value of y, say M_1. As before, we should like to find a confidence interval for M_1 so that, for $x = x_1$, we could place a fair bet that M_1 was contained in the interval.

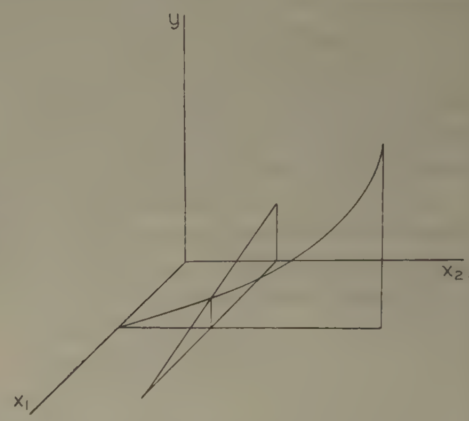


Figure 5. Illustration of limitation of functional graph

Using the method of least squares (reference 1 contains a brief discussion of the method) we get

$$Y = a + b(x - x_{mean})$$

as the estimating formula. The numerical values of a and b are found by minimizing

$$\sum_{i=1}^{n}(y_i - Y_i)^2$$

Representing this minimum value by S, we use the relation

$$s^2_{y \cdot x} = \frac{S^2}{n-2}$$

to calculate $s_{y \cdot x}$, an estimate for the standard deviation of y for any specified value of x (a measure of the spread of the y values away from the true regression line).

To get a confidence interval for M_1, the true mean of y when $x = x_1$, we use the following facts:

1. The best estimate of M_1 is $Y_1 = a + b(x_1 - x_{mean})$
2. The best estimate of the variance of $(Y_1 - M_1)$ is

$$s^2_{y \cdot x}\left(\frac{1}{n} + \frac{(x_1 - x_{mean})^2}{\Sigma(x_i - x_{mean})^2}\right)$$

(Variance is standard deviation squared.)

3. $[Y_1 - M_1] \div s_{y \cdot x}\sqrt{\frac{1}{n} + \frac{(x_1 - x_{mean})^2}{\Sigma(x_i - x_{mean})^2}}$ has the t distribution with $n-2$ degrees of freedom (assuming normality of deviations of observed y values from the corresponding estimates, and the same variance of y for each value of x).

Using this information it follows that the 95 per cent confidence limits for M are

$$a + b(x_1 - x_{mean}) \pm t_{0.025} \cdot s_{y \cdot x}\sqrt{\frac{1}{n} + \frac{(x_1 - x_{mean})^2}{\Sigma(x_i - x_{mean})^2}}$$

and that the confidence band is bounded by hyperbolas.

A glance at Figure 7 may help to clarify the situation. The location of the true regression line TT' is unknown, but with the aid of the data we estimate it to be the line SS'. For a particular value of x, say x_1, we estimate M_1 to be EF. Confidence limits for this estimate are EG and EH. The confidence band is narrowest at x_{mean} because we lose the second term under the radical in the formula for confidence limits. As we move away from x_{mean} in either direction, the band widens out.

How much help does this give us in predicting a new *individual* value of y for one of the x values, say x_1? The best estimate for y is

$$Y_1 = a + b(x_1 - x_{mean})$$

and 95 per cent confidence* limits for this estimate are

$$a + b(x_1 - x_{mean}) + t_{0.025} \cdot s_{y \cdot x} \sqrt{1 + \frac{1}{n} + \frac{(x_1 - x_{mean})^2}{\Sigma(x_i - x_{mean})^2}}$$

We notice that, as x varies, these confidence limits describe another hyperbola but that the deviations from the least squares' line are much greater than for the previous case where we were concerned only with setting confidence limits for the mean.

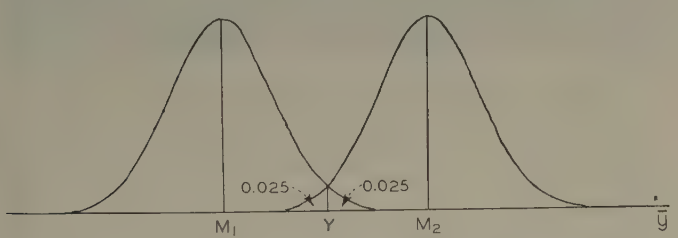


Figure 6. Illustration of method of setting confidence limits

Y is the average value of y observed in a sample of size n. The left-hand curve represents the distribution of values of y_{avg} when $M = M_1$ and the right-hand curve represents the distribution when $M = M_2$

Confidence limits apply to average results in repeated experiments under controlled conditions, and so do estimates. If the experiment is performed a number of times, using the same set of values for x, then a is expected to have a stable approach to α, b to β, and $y_{1,avg}$ to $\alpha + \beta(x_1 - x_{mean})$. As before, control chart techniques may be applied. Lack of control indicates the presence of "assignable" causes of variability. We assumed that y was a linear function of x and of x only and that the variation of y_1 from M_1 was chance variation. Lack of control may indicate that y, in fact, depends on other variables beside x and that our theory is in need of revision.

In case y is assumed to be a linear function of several variables we can use the method of least squares to obtain a predicting formula of the form

$$Y = a_0 + a_1x_1 + a_2x_2 + \ldots + a_nx_n$$

* Technically, these are fiducial limits, but the practical interpretation is substantially the same as for confidence limits.

The expected (or true mean) value of y corresponding to a

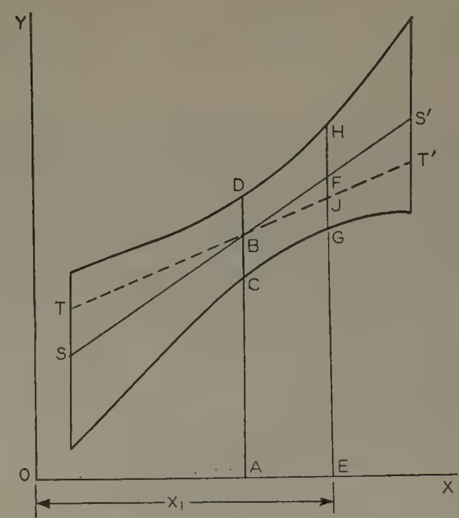


Figure 7. Confidence band for estimates based on linear regression

TT' is the true regression line, $M = \alpha + \beta(x - x_{mean})$
SS' is the calculated regression line, $Y = a + b(x - x_{mean})$
$OA = x_{mean}$; $OE = x_1$ (any other value of x); $AB = Y_{xmean}$. AC and AD are the confidence limits for Mx_{mean}; $EF = Y_1$; $EJ = M_1$ (unknown); EG and EH are the confidence limits for M_1

specified set of x values can be estimated, and confidence limits for the estimated mean can be calculated. The necessary formulas, together with an excellent discussion of their origin, are given in reference 2.

Suppose y is assumed to be a polynomial function of a single variable, with a predicting formula

$$Y = b_0 + b_1x + b_2x^2 + \ldots + b_nx^n$$

Then, as Cramér indicates, the method of solution for constants and confidence interval is no different from the previous case. We set $x_1 = x$, $x_2 = x^2$, ..., $x_n = x^n$, and proceed as before.

Summarizing very briefly, we analyze data in order to get a sound basis for action on a dependent variable y. Either we want to control it or change it. After fitting the best theoretical functions to our data, we can estimate the true mean value of y for a sets of x's and give a numerical measure to our confidence in this estimate. Control chart techniques can be used advantageously to improve estimates as more experimental data become available.

A final remark—the idea of using confidence limits is not very new, but it is quite useful. Engineers seem to have been rather slow in taking advantage of it. There is no guarantee, however, that results will be comforting. On the contrary, the methods may show how shaky some predictions really are.

REFERENCES

1. Introduction to Mathematical Statistics (book), **Hoel.** John Wiley and Sons, New York, N. Y., 1947, chapter 5.

2. Mathematical Methods of Statistics (book), **Cramér.** Princeton University Press, 1946, chapter 37.

Electrification of an Ore Haulage System

R. J. CORFIELD
MEMBER AIEE

APPROXIMATELY 28 single track or 17.5 route miles of electrified railroad constructed for the specific purpose of hauling 30 million tons of relatively low grade copper-bearing ore between the open pit mine at Bingham Canyon, Utah, and the two copper concentrators located at Garfield, Utah, were placed in operation on May 1, 1948.

This electric railway is an entirely new project and completely replaces the original haulage system which lay to the west in a fairly rugged terrain. The old system had a ruling grade of 2.5 per cent and curves as sharp as 10 degrees. Its motive power was coal-burning Mallet-type locomotives weighing 350 tons and having a starting tractive effort of 117,000 pounds simple and 98,000 pounds when compounded. These locomotives normally handled a train of 46 cars at an average speed of 10 miles an hour up-grade. The new system is designed to handle 75-car trains at a speed of 25 miles per hour.

The new railroad is on a 1.35 per cent grade and is laid with 131-pound rail on hardwood ties. Crushed smelter slag is used for ballast. A single 2-mile passing track is provided at the middle of the line and all train meets will be at this point. The latest type of centralized traffic control is used to govern all train movements from one central point. All routing switches in yards and on the main line are electrically operated and provided with electric snow melters.

Train radio ultimately will be used between the operator's control tower to various way stations and train crews. In addition, end-to-end communication between train crews will be provided.

This railroad is operated at 3,000 volts, direct current. Conversion equipment consists of single-anode-type rectifiers. A single substation, installed at the load center, supplies power. This substation contains two 3,000-kw 3,200-volt rectifiers together with necessary auxiliaries and fully automatic switchgear.

The locomotives selected for this application are special in certain respects; they weigh 125 tons each, all weight on drivers, and two will be coupled together to make one road engine. The two cabs have a continuous rating of 6,200 horsepower and a one-hour rating of 6,600 horsepower. They are geared to develop about 90,000 pounds tractive effort continuously at 26 miles per hour, resulting in a running adhesion of 18 per cent.

These locomotives (Figure 1) feature all-welded construction. The trucks are exceptionally heavy, weighing approximately 40 tons each. The main deck plate is two inches thick and weighs approximately 20 tons. The cab structure and auxiliary equipment compartments are of welded sheet steel and the cab is completely insulated. All compartment doors housing high-voltage control equipment are master-keyed to prevent entrance of unauthorized personnel. All motors are equipped with antifriction bearings arranged for grease lubrication.

Figure 1. A single main line locomotive is made up of two 125-ton cabs

Both locomotives are operated from a single cab

Trailing load up-grade will consist of 75 ore gondolas and a caboose. Train weight will be 1,820 tons. Down-grade trains will weigh 8,570 tons. Speed is between 24 and 26 miles per hour both ways. Full dynamic braking is provided to reduce brake shoe wear and permit smooth handling of the heavy tonnage down grade.

Locomotives are equipped with dual voltage control at 3,000/750 volts because all mine tracks are electrified at 750 volts. The changeover is done manually from a single controller; however, electric interlocking is provided between the two voltages in order to protect the equipment against man failure.

The 3,000-volt power is supplied to the locomotives through a compound catenary system supported by wood poles. The catenary is made up of a 1/2-inch copper-coated-steel main messenger, a number 4/0 copper auxiliary messenger, and a number 6/0 grooved trolley wire. This catenary system is fed from two 1,000,000-circular-mil bare feeders with alternate trolley taps every thousand feet.

The purpose of this electrification is primarily economic and all types of modern motive power were investigated. All factors considered, straight electric operation proves to be the most economical application for this application.

Digest of paper 48-205, "Electrification of an Ore Haulage System," recommended by the AIEE land transportation committee and approved by the AIEE technical program committee for presentation at the AIEE Pacific general meeting, Spokane, Wash., August 24–27, 1948. Scheduled for publication in AIEE *TRANSACTIONS*, volume 67, 1948.

R. J. Corfield is electrical engineer, Kennecott Copper Corporation, Utah Copper Division, Garfield, Utah.

A Universal Telemetering System

L. DALE HARRIS
ASSOCIATE AIEE

IT IS BELIEVED that there is a need of a general telemetering method that can be applied to any one of a wide variety of telemetering problems. There is a need for some basic circuit or device that could be adapted readily to the metering of flow in a remote gas main, temperature in the cylinder wall of a remote aircraft, the current in a remote alternator, or the remote indication of any one of numerous measureable quantities of engineering interest. If the engineer merely had to adapt a basic telemetering device through minor modifications, the design of a device or circuit for a new telemetering problem might be simplified considerably.

The particular telemetering system under discussion here and shown in Figure 1 employs frequency as a translation medium; that is, the quantity to be metered at a distance is translated to an equivalent frequency at the sending end for transmission over pilot wires, carrier current, or conventional radio links. At the receiving end of the system the frequency is converted back to a direct current or voltage in proportion to the original quantity being metered remotely. This translation for transmission is needed to avoid the effect of changing transmission characteristics on the indication at the receiving end of the system. These various functions

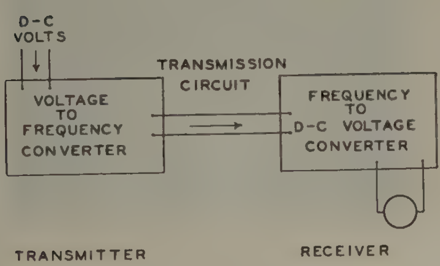


Figure 1. Block diagram showing basic features of the universal telemetering system—a d-c televoltmeter

are performed by vacuum tube circuits which operate such that the accuracy of the indicator at the receiving end is essentially independent of drifting tube characteristics. A minimum number of moving parts are employed. In the telemetering of many of the common quantities, no moving parts are in the system except the voltmeter or ammeter used as the indicator at the receiving end. For example, an a-c teleammeter employs only vacuum tube circuits using simple conventional components at both the sending end and receiving end plus a simple d-c milliammeter as an indicator at the receiving end.

The over-all accuracy of this telemetering system is good. A particular laboratory model of an a-c teleammeter had a maximum error of 0.5 per cent.

Digest of paper **48-204**, "A Universal Telemetering System," recommended by the AIEE joint subcommittee on telemetering and approved by the AIEE technical program committee for presentation at the AIEE Pacific general meeting, Spokane, Wash., August 24–27, 1948.

L. Dale Harris is professor, department of electrical engineering, University of Utah, Salt Lake City, Utah.

For this system of telemetering to find application, either the quantity to be telemetered must be a direct voltage or there must be a way of converting the quantity to an equivalent direct voltage. Fortunately, many measurable quantities can be converted to their respective equivalent direct voltages. Some examples are alternating and direct

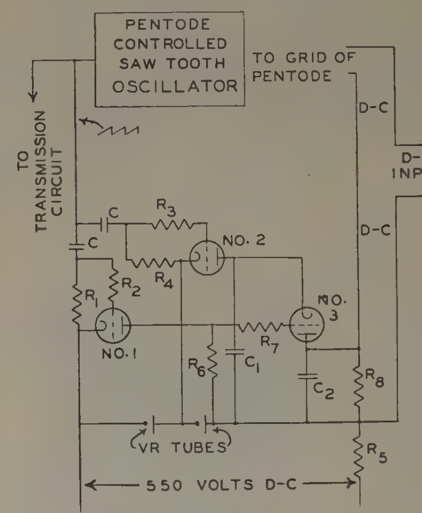


Figure 2. Transmitter (content of left-hand block of Figure 1)

current, alternating voltage, resistance, power, flow, position, temperature, and pressure. However, special problems arise relative to the telemetering of power. As far as the writer knows, there is no extremely simple circuit or device available that will accurately convert power to an equivalent direct voltage. Laboratory work indicates that electronic wattmeter circuits will not yield accuracies within one per cent where the voltage and power factor may change over rather wide ranges. Other devices that incorporate the basic wattmeter or watt-hour meter movements might be used but at the loss of simplicity.

In general the telemetering system will include a d-c televoltmeter, a complete telemetering system, plus a converter (Figure 2) at the sending end for converting the quantity to be metered remotely to a direct voltage. The d-c televoltmeter is basic to all applications of this universal system. Each new application merely requires that the quantity to be metered remotely must be converted to its equivalent direct voltage, then the addition of the basic d-c televoltmeter yields a complete telemetering system.

The transmission circuit carries a low frequency signal that may be amplified, detected, become a part of a modulated high frequency signal, or otherwise manipulated in any of the conventional communication operations. Within wide limits, the output of the frequency-to-direct-voltage converter is practically independent of the magnitude of the received signal. For this reason there can be no important error introduced into the d-c indicator at the receiver end by the ordinary changes in the transmission circuit and its associate apparatus.

INSTITUTE ACTIVITIES

Our Institute Membership

—*A Message From the President*

When I tell my friends who are not engineers of our Institute, and of our 30,000 corporate members and of our 14,000 Student Members studying electrical engineering in the engineering schools of our land, and of our Sections throughout our land, and of our Student Branches in 127 engineering schools, and of our technical committees of over 2,000 members, and of our membership reaching around the world, they marvel. They ordinarily think of us as associated with blue prints, and as men apart.

But when I tell them of the contributions of the engineer and of the electrical engineer to provide for their every material thing they have, they there see in the contributions of the electrical engineer what they have from the electrical engineer and how they need it and use it in every minute of their daily lives.

Then they recognize in the contributions of the electrical engineer that recognition which so many engineers feel is due them but which they do not have. And yet they will have it if they will but use the opportunities they have for making it clear to the world just what has been done. This is an outstanding opportunity in Institute membership.

I was asked at our Pacific general meeting in Spokane to address the Spokane Chamber of Commerce. I chose as my subject "Spokane and the American Institute of Electrical Engineers." After reviewing the wonderful progress in the Pacific-Northwest, of which Spokane is a center, I said,

> Now I want to speak of our American Institute of Electrical Engineers. In back of every project which I have brought to your attention which you have progressed in your Inland Empire stands the engineer. Nothing is produced that has not felt the hand and the head and the heart of the engineer. In back of all of your great dams and reclamation projects are the civil engineers. In all of your machinery in your factories, on your farms, or in your mines are the mechanical engineers. In all of your metallurgy are the mining engineers. In all of your factory chemical processes are the chemical engineers. And in all of your electric power and machinery everywhere, in all of your home and office electric appliances, in your lighting, in your telephone and telegraph and radio and television and movies, are the electrical engineers. Every material thing we have comes from the engineers, and in the electrical field, everything we have comes from the electrical engineers. And yet rarely is this mentioned.

It is through the meetings of our Institute, and there were 2,500 of these last year, that if engineers would take the time to make clear to the public through the press and the forum the purpose of the technical discussion of the meeting to the people so they would understand, it would not be long before this phase of our Institute opportunity would be productive to bring to our electrical engineers the recognition beyond that which they now have which many of them feel is rightfully theirs. And it is within their opportunity to make it clear. Our Institute membership affords that opportunity.

There is much more to say. Our coverage of membership is wide; our member distribution is over many fields, approximately as follows:

	Per Cent
Electric light and power	22
Electrical manufacturing	22.5
Industrial and transportation	13
Communication	9
Government	9
Consulting and large contracting	7
Professors and instructors	3.5
All others	14
Total	100
Students	50

For every member we have it is our best estimate that there is another electrical engineer eligible for membership in our Institute whom we have not. This is a challenge to each member to look about him and interest in our Institute and invite to our meetings those of our associates in electrical engineering who by their attainments are eligible. Both we and they would be mutually advanced. Support your Section membership committees in this work; they have been most loyal in giving of their abilities to advancing our Institute membership. Help them all you can.

Through the excellent work of our Section transfer committees, more and more of our members are advancing themselves appropriately in member grade. As of August 1, 1948 our status is:

Everett S. Lee

Associates	12,575
Associates (more than 6 years)	7,892
Members	8,318
Fellows	1,108
Honorary	8
Total	29,901

The opportunity for advancement in grade appropriate to his attainments in his electrical engineering life is one of the opportunities of Institute membership in which each member should have great pride.

We are the largest engineering society in the world. That should make us proud of our electrical engineering contributions. That should make us proud of our Institute. That should make us want to make it ever better and better. That should make each one of us want to work for it ever more and more.

Completion of Plans Announced for Midwest General Meeting

Arrangements are being completed for the program of the Midwest general meeting to be held in Milwaukee, Wis., October 18–22, 1948. Meeting headquarters will be in the Schroeder Hotel. The technical program is broad in scope embracing a number of sessions in each of three main groups of Institute technical activity, namely; communications and sciences, power, and industry.

A delightful series of events, consisting of entertainment during the evenings, golf on Tuesday afternoon, inspection trips, and a special womens' program, have been arranged by the Midwest general meeting committee. The complete account of these events as well as other features of interest in Milwaukee and vicinity, together with information pertaining to hotel reservations, was published in *ELECTRICAL ENGINEERING* for September, pages 911–13. Slight changes in these features are noted in the following.

INSPECTION TRIPS

The inspection trip to the Line Material Company will not be made as the new testing laboratory has not been completed. In its place, a trip has been arranged to see the hydraulic model of the liquid-cooled generator at the Milwaukee School of Engineering. Very large thermal gains may be effected by using a liquid instead of a gas as a cooling medium. The mechanical difficulties associated with liquid cooling of a turbogenerator rotor have been overcome by C. J. Fechheimer. In the model, 55 gallons of water flow with the rotor running at 3,560 rpm, which is sufficient for a 50,000-kva rotor with only 14 degrees Fahrenheit rise for the water. The model may be seen in operation at the Milwaukee School of Engineering, 1020 North Broadway.

WOMEN'S PROGRAM

The women's program is complete except there will be a luncheon and style show at the Milwaukee Country Club on Wednesday, October 20, instead of a tour of art institutes and historic societies. On Thursday afternoon, October 21, a bridge luncheon will be held at the Milwaukee Athletic Club.

Members and guests should register in advance by promptly filling in and mailing the advance registration card. To help defray part of the cost of the meeting, a registration fee of $3 will be charged to members; nonmembers $5. No fee will be charged to Student members and the families of members. Those who have not already made a hotel reservation, should do so at once by writing directly to the hotel preferred as listed in *ELECTRICAL ENGINEERING* for September, page 913.

MIDWEST GENERAL MEETING COMMITTEE

Members of the Midwest general meeting committee making the arrangements are

E. W. Seeger, *chairman;* E. U. Lassen, *vice-chairman;* E. F. Mekelburg, *secretary;* J. A. Potts, *treasurer;* L. C. Aicher; M. A. Baker; K. R. Brown; C. C. Crane; E. H. Davies; T. G. Glenn; F. C. Holtz; J. H. Kuhlman; A. J. Krupy; R. Neighbouhs; J. C. Strasbourger.

The chairman of subcommittees are

W. Richter, *technical program;* E. J. Limpel, *inspection trips;* B. F. Tellkamp, *entertainment;* W. O. Helwig, *sports;* E. M. Plettner, *transportation;* E. T. Sherwood, *publicity;* F. W. Bush, *finance;* Mrs. E. L. McClure, Mrs. E. W. Seeger, *ladies;* R. Earle, *registration and housing;* G. Hutchinson, *equipment;* M. M. Iglehart, *hotels;* C. H. Krueger, *registration.*

Schedule of Events

Monday, October 18

8:30 a.m.	Registrations
10:00 a.m.	Opening General Meeting
1:15 p.m.	Trip to Port Washington power plant
1:30 p.m.	Trip to Harnischfeger Corporation
2:00 p.m.	Transformers
	Basic sciences
	Electric heating
7:30 p.m.	Trip to Blatz Brewing Company
	Trip to Pabst Brewing Company
	Trip to Joseph Schlitz Brewing Company

Tuesday, October 19

9:30 a.m.	System engineering
	Conference on nuclear physics
	Mining
	Home receivers
	Symposium on circuit analysis
	Trip to Cutler-Hammer, Inc.
12:30 p.m.	Luncheon at Allis-Chalmers clubhouse
1:15 p.m.	Trip to Allis-Chalmers Manufacturing Company
2:00 p.m.	System engineering
	Conference on ore beneficiation
	Conference on television broadcasting
	Conference on industrial control
6:30 p.m.	Stag smoker

Wednesday, October 20

9:30 a.m.	Insulated conductors
	Industrial control
	Conference on electric heating
1:30 p.m.	Trip to Globe-Union, Inc.
	Trip to Square D Company
2:00 p.m.	Power generation
	Regulators
	Industrial power systems
	Conference on electric heating
6:30 p.m.	Banquet and dance

Thursday, October 21

9:30 a.m.	Insulator contamination
	Symposium on speed regulating systems for sectional paper machine drives
	Steel mills
	Railroad communications
	Carrier current
	Trip to A. O. Smith Corporation
1:30 p.m.	Trip to Allen-Bradley Company
2:00 p.m.	Transmission and distribution and outdoor substation design
	Conference on material handling
	Land transportation
7:30 p.m.	Milwaukee Gemeutlichkeit

Friday, October 22

9:30 a.m.	Switchgear
	Conference on automatic contouring for machine tools
	Switching systems
	Joint conference on education and Student Branches
	Trip to liquid-cooled alternator at Milwaukee School of Engineering
2:00 p.m.	Relays
	Conference on automatic contouring for machine tools (continued)
	Radio on Great Lakes

AIEE PROCEEDINGS

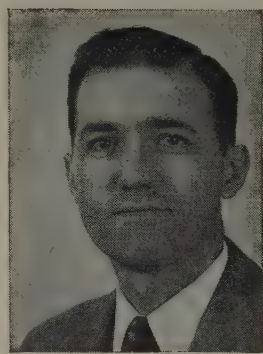
Order forms for current AIEE *PROCEEDINGS* have been published in *ELECTRICAL ENGINEERING* as listed below. Each section of AIEE *PROCEEDINGS* contains the full, formal text of a technical program paper, including discussion, if any, as it will appear in the annual volume of AIEE *TRANSACTIONS*.

AIEE *PROCEEDINGS* are an interim membership service, issued in accordance with the revised publication policy that became effective January 1947 (*EE, Dec '46, pp 576–8; Jan '47, pp 82–3*). They are available to AIEE Student Members, Associates, Members, and Fellows only.

All technical papers issued as AIEE *PROCEEDINGS* will appear in *ELECTRICAL ENGINEERING* in abbreviated form.

Location of Order Forms	Meetings Covered
Apr '48, p 49A	Winter general
Aug '48, p 45A	Great Lakes District North Eastern District Summer general
Oct '48, p 43A	Pacific general Middle Eastern District

C. C. Wilson Dies; Was on AIEE Headquarters Staff


C. C. Wilson

Charles Callaway Wilson, able member of the AIEE administrative staff at Institute headquarters in New York City, died August 12, 1948, at his home in Mount Vernon, N. Y. Up until his death, Wilson had been assistant to H. H. Henline, AIEE national secretary, a position he had held since joining the AIEE headquarters staff on September 15, 1946.

Acting for Secretary Henline, Mr. Wilson was active in correlating the work of the many technical committees and subcommittees. He contributed in a major way to the development and smooth functioning of the Institute's technical activities program, and was instrumental in the recent reorganization of the entire AIEE committee structure. He was especially helpful in working with the various committees and their chairmen in the initiation of the new type of AIEE meetings which have become known as AIEE technical conferences.

Aside from his committee liaison work, Mr. Wilson was also secretary of four AIEE committees. These were: industry co-ordinating, power co-ordinating, electric welding, and publications.

Prior to joining the AIEE headquarters staff, Mr. Wilson was employed as electrical design engineer in charge of the engineering design section of the Ward Leonard Company, Mount Vernon, N. Y., and during World War II, he aided that company in its development of electric motor control apparatus for use by the United States Navy. (For complete biographical details, see page 1021).

Tentative Technical Program

Midwest General Meeting, Milwaukee, Wis., October 18-22, 1948

Monday, October 18

8 : 30 a.m. Registration

10 : 00 a.m. Opening Meeting

2 : 00 p.m. Transformers

48-289. Aging Characteristics of Dry-Type Transformer Insulation at High Temperature. *H. C. Stewart, L. C. Whitman,* General Electric Company

48-290. Measuring Transformer Winding Temperatures Continuously With the Transformer Carrying Load. *A. M. Lockie, G. M. Stein,* Westinghouse Electric Corporation

48-291. Experience with Transformer Impulse Failure Detection Methods. *L. C. Aicher, Jr.,* Allis-Chalmers Manufacturing Company

48-292. Voltage Stresses in Distribution Transformers Due to Lightning Currents in Low-Voltage Circuits. *K. D. Beardsley, W. A. McMorris, H. C. Stewart,* General Electric Company

2 : 00 p.m. Basic Sciences

48-274. Bridge Erosion in Electrical Contacts and Its Prevention. *W. G. Pfann,* Bell Telephone Laboratories, Inc.

48-275. The Magnetic Properties of Stainless Steels. *W. A. Stein,* Washington University

48-276. Proximity Effect Factors for 3-Phase Coaxial Busses Comprised of Square Tubular Conductors. *T. J. Higgins,* University of Wisconsin

48-277-ACO. Stabilized Permanent Magnets.** *P. P. Cioffi,* Bell Telephone Laboratories, Inc.

2 : 00 p.m. Electric Heating

48-286-ACO. Ultrahigh-Frequency Antenna Considerations for Radiation Measurements.** *H. E. Dinger, G. E. Leavitt,* Naval Research Laboratory

48-287. Mercury-Arc Furnace Converter for Induction Heating of Metals. *S. R. Durand, J. B. Rice,* Allis-Chalmers Manufacturing Company

48-247. Industrial Electric Resistance Heating. *L. P. Hynes,* Hynes Electric Heating Company

Tuesday, October 19

9 : 30 a.m. System Engineering

48-265-ACO.* Planning the Development of a Large All-Hydro System. *M. Ward, H. A. Smith,* Hydro-Electric Power Commission of Ontario

48-266. Planning the Development of a Metropolitan Electric System. *M. L. Waring,* Consolidated Edison Company of New York, Inc.

48-267. Emergency Control of System Loads. *J. M. Comly, J. E. McCormack,* Consolidated Edison Company of New York, Inc.; *C. B. Kelley, T. W. Schroeder,* The United Light and Railway Service Company; *H. W. Phillips,* Pennsylvania-New Jersey Interconnection

9 : 30 a.m. Conference on Nuclear Physics

CP.* Recent Developments in the Design of High-Energy Accelerators for Atomic Particles. *J. T. Wilson,* Allis-Chalmers Manufacturing Company

9 : 30 a.m. Mining

48-269. Evolution of Ward-Leonard Control for Shovels and Draglines. *P. S. Stevens,* Bucyrus-Erie Company

*CP. Conference paper; no advance copies are available; not intended for publication in *TRANSACTIONS.*

** ACO. Advance copies only available; not intended for publication in *TRANSACTIONS.*

—PAMPHLET reproductions of author's manuscripts of the numbered papers listed in the program may be obtained as noted in the following paragraphs.

—PRICES for papers, irrespective of length, are 30 cents to members (60 cents to nonmembers) whether ordered by mail or purchased at the meeting. Mail orders are advisable, particularly from out-of-town members, as an adequate supply of each paper at the meeting cannot be assured. Only numbered papers are available in pamphlet form.

—COUPONS books in five-dollar denominations are available for those who may wish this convenient form of remittance.

—THE PAPERS regularly approved by the technical program committee ultimately will be published in PROCEEDINGS and TRANSACTIONS; also, each is scheduled to be published in ELECTRICAL ENGINEERING in digest or other form.

48-270. Electric Equipment for Power Shovels and Draglines. *W. H. Schwedes, D. Stoetzel,* General Electric Company

CP.* The Use of Electricity in the Operations of the Calumet and Hecla Consolidated Copper Company. *J. E. Breth,* Calumet and Hecla Consolidated Copper Company

CP.* Main Line Track Haulage in Mines. *Phelan McShane,* Westinghouse Electric Corporation

9 : 30 a.m. Home Receivers

48-278. Television Receiving Systems. *C. M. Sinnett,* Radio Corporation of America

48-272. FM Receiver Design Trends. *G. G. Young,* General Electric Company

CP.* The Columbia Long Playing Microgroove Recording System. *P. C. Goldmark,* Columbia Broadcasting Studios

CP.* Lightweight Pickup Design for Microgroove Records. *B. P. Haines,* Philco Corporation

9 : 03 a.m. Symposium on Circuit Analysis

CP.* The History and Present State of the Operational Calculus as Applied in Electric Circuit Analysis. *T. J. Higgins,* Illinois Institute of Technology

CP.* The History and Present State of the Application of Matrix Algebra in Electric Circuit Analysis. *Myril Reed,* University of Illinois

CP.* Circuit Analysis in Servomechanism Theory. *C. N. Weygandt,* University of Pennsylvania

2 : 00 p.m. System Engineering

48-268. Continuous Load-Frequency Control for Interconnected Power Systems. *H. M. Dimond, G. S. Lunge,* General Electric Company

CP.* Report on Questionnaire "Current Status of Load-Frequency Control."

CP.* Designing Boiler and Control Equipment for Fluctuating Loads. *P. S. Dickey,* Baley Meter Company; *P. R. Loughin,* Babcock and Wilcox Company

CP.* Effect of Fluctuating Load on Steam Turbines. *R. L. Reynolds,* Westinghouse Electric Corporation

2 :00 p.m. Conference on Ore Benefication

CP.* Introductory Talk on Ore Beneficiation. Official of United States Steel Corporation

CP.* Heavy Media Separation. American Cyanamid Company

CP.* Magnetic Separation. Ding Magnetic Company

48-313. Power Distribution and Utilization in a Large Iron Ore Beneficiation Plant. *A. F. Gettleman,* General Electric Company

2 : 00 p.m. Television Broadcasting

48-273. Progress in Coaxial Telephone and Television Systems. *L. G. Abraham,* Bell Telephone Laboratories, Inc.

CP.* New York to Schenectady Television Relay. *F. M. Deerhake,* General Electric Company

CP.* Stratovision Broadcasting. *C. E. Nobles,* Westinghouse Electric Corporation

CP.* Fundamental Design Problems Regarding Television Transmitters. *G. E. Hamilton,* Allen B. DuMont Laboratories, Inc.

CP.* Recent Development in Semiconductors and the Transistor. *J. A. Becker,* Bell Telephone Laboratories, Inc.

2 : 00 p.m. Conference on Industrial Control

CP.* Thermal Overload Relays for the Protection of Motors Driving High Inertia Loads. *R. E. Walters,* Allen-Bradley Company

CP.* An A-C Operated Magnetically Latched Contractor. *L. H. Mathias,* Allen-Bradley Company

CP.* Inching Control for Large A-C Motors. *R. M. Peeples, W. J. Herzinger,* Allis-Chalmers Manufacturing Company

CP.* The Application of Regulex to Improve Steady State Stability. *J. F. Sellers, L. T. Rosenberg, T. B. Montgomery,* Allis-Chalmers Manufacturing Company

CP.* Automatic Power Factor Control on Synchronous Motors. *T. H. Bloodworth, L. T. Rosenberg,* Allis-Chalmers Manufacturing Company

Wednesday, October 20

9 : 30 a.m. Insulated Conductors

48-253. Polyethylene-Insulated Coaxial Cable for Carrier Current Control Circuit. *H. B. Slade,* The Okonite Company; *F. P. West,* Consolidated Edison Company of New York, Inc.

48-249. Problems in the Measurement of A-C Resistance and Reactance of Large Conductors. *E. H. Salter,* Electrical Testing Laboratories, Inc.

48-254. A-C Resistance of Large Size Conductors in Steel Pipe or Conduit. *R. J. Wiseman,* The Okonite Company

48-252. Reactance of Large Cables in Steel Pipe or Conduit. *W. A. Del Mar,* Phelps Dodge Copper Products Company

9 : 30 a.m. Industrial Control

48-283. Application of Low Frequency to Industrial Control Problems. *N. L. Schmitz,* Cutler-Hammer, Inc.

48-284. Dynamic Lowering D-C Hoist Control. *D. L. Pettit,* Square D Company

CP.* Some Machine Tool Electrical Control Applications. *Leonard Hesse,* Gisholt Machine Company

CP.* Safety in Machine Tool Control. *D. K. Frost,* Mattison Machine Works

48-285. Wound Rotor Induction Motors for Synchronized Drives. *E. L. Schwartz-Kast,* Armour Research Foundation

48-279. The Characteristics and Application of Precision, Snap-Acting Switches. *A. L. Riche*, First Industrial Corporation

9:30 a.m. Conference on Electric Heating

CP.* Determination of Heat Requirements. *Mark M. Greer*, Edward L. Wiegand Company

CP.* Application of Electric Heating Units for Surface Heating. *C. R. Hanna*, General Electric Company

CP.* Electric Heating of Fluids. *Lee P. Hynes*, Hynes Electric Heating Company

CP.* Application of Electric Heating Units for High-Velocity Air Heating for Processing Materials. *R. J. Ruff*, Young Brothers Company

CP.* Review of Developments in Controlled Atmosphere Electric Furnaces. *C. E. Peck*, Westinghouse Electric Corporation

2:00 p.m. Power Generation

48-280. Speed Governing Design Considerations for Multivalve Condensing Steam Turbine-Generators. *J. W. Barnett*, General Electric Company

48-281. Preliminary Consideration of System-Wide Load Division by Means of Accurate Time Control. *T. E. Curtis, W. M. Pickslay*, Pacific Gas and Electric Company

48-282. Performance Characteristics of Speed Governors on Automatic Extraction Turbines Driving Electric Generators. *L. B. Wales*, General Electric Company

2:00 p.m. Regulators

48-177. Feeder Voltage Accuracy Standards. *W. E. Birchard*, General Electric Company

48-261-ACO. Proposed Test Code for Feeder Voltage Regulators.** *Working group of ASA C57 test code subcommittee*

48-263. Feeder Voltage Regulator Application on Power Systems. *J. N. Gosinski, J. R. Oberholtzer*, Commonwealth and Southern Corporation

48-264. Power System Voltage Control Without Feeder Voltage Regulators. *N. N. Smeloff*, Pennsylvania Power and Light Company

2:00 p.m. Industrial Power Systems

48-293. Dummy Loads Applied to Large Industrial Welders to Reduce Voltage Fluctuations. *A. W. Brown, S. W. Johnson*, Illinois Northern Utilities Company

48-294-ACO. Flexible Power System for Rapidly Expanded Heavy Manufacturing Plant.** *H. J. Decker*, General Motors Corporation

2:00 p.m. Conference on Electric Heating

CP.* The Resistance Furnace in the Nonferrous Metal Industry. *E. H. Scheick*, American Smelting and Refining Company

CP.* Radiant Heating. *H. J. Garber*, University of Tennessee

CP.* Induction Heating. *W. C. Rudd*, Induction Heating Corporation

CP.* Dielectric Heating. *W. H. Hickok, T. L. Wilson*, Girdler Corporation

CP.* Some Economic Aspects of Radio-Frequency Heating. *L. M. Duryee*, Connecticut Light and Power Company

Thursday, October 21

9:30 a.m. Insulator Contamination

48-307. Flashovers of Suspension Insulators Due to Contamination. *H. A. Adler, W. H. Wickham*, Commonwealth Edison Company; *M. S. Oldacre*, Utilities Research Commission

48-308. Performance of Dust-Contaminated Insulators in Fog. *Bradley Cozzens, T. M. Blakeslee*, Water and Power Department, City of Los Angeles

48-255. Insulator Surface Contamination. *H. A. Frey*, Locke, Inc.

48-259. Insulators to Withstand Air-borne Deposits. *J. J. Taylor*, Ohio Brass Company

9:30 a.m. Symposium on Speed Regulating Systems for Sectional Paper Machine Drives

48-295. Electronic Speed Regulators for Sectional Paper Machine Drive. *V. B. Baker, J. F. Kovalsky*, Westinghouse Electric Corporation

CP.* The Differential Interlock Regulating System for Sectional Paper Machine. *J. L. Van Nort*, Reliance Electric and Engineering Company

CP.* The Electronic Amplidyne Regulating System for Sectional Paper Machine Drive. *W. Mikelson*, General Electric Company

9:30 a.m. Steel Mills

CP.* History of Development of Blooming Mill Drives. *G. E. Stoltz*, Westinghouse Electric Corporation

48-271. The Reversing Cycle of Modern Blooming Mills. *T. B. Montgomery, J. F. Sellers*, Allis-Chalmers Manufacturing Company

CP.* Auxiliary Drives for Blooming and Slabbing Mills—Selection of Motor Size and Gear Ratio. *R. E. Marrs, S. H. Williamson*, General Electric Company

9:30 a.m. Railroad Communications

CP.* Railroad Communication Systems of the New York Central. *G. L. Miller*, New York Central Railroad

48-315-ACO. Railroad Radio.** *W. D. Hailes*, General Railway Signal Company

CP.* Radiotelephone Service for Passengers Utilizing Bell System Highway Channels. *Newton Monk*, Bell Telephone Laboratories, Inc.

9:30 a.m. Carrier Current

48-262. Carrier Channels for Telemetering. *T. D. Talmage*, Tennessee Valley Authority

48-296. System Operation Improved with Carrier Telemetering and Load Control. *A. W. Walton*, Oklahoma Gas and Electric Company; *H. W. Lensner*, Westinghouse Electric Corporation

48-297. Characteristics of New Carrier-Current Equipment for Telemetering and Load Control. *R. W. Beckwith*, General Electric Company

48-256. Coupling Capacitors and Traps for Rural Line Carrier. *Carrier current committee*

48-257. Report on Method of Measurements at Carrier-Current Frequencies. *Carrier current committee*

2:00 p.m. Transmission, Distribution, and Outdoor Substation Design

48-319. Pole Fires Due to Insulator Contamination. *W. H. Wickham, H. A. Adler*, Commonwealth Edison Company; *M. S. Oldacre*, Utilities Research Commission

48-285. Relative Surface Voltage Gradients of Grouped Conductors. *M. Temoshok*, General Electric Company

48-298. Channels for Operation of Supervisory Control Equipment. *W. A. Derr, M. J. Brown*, Westinghouse Electric Corporation

48-299-ACO. Design Considerations of Transmission Substations.** *A. H. Powell, L. D. Madsen*, General Electric Company

2:00 p.m. Conference on Material Handling

CP.* Electric Truck Control Systems. *D. I. Bohn, T. O. English*, Aluminum Company of America

CP.* Magnetorque A-C Crane Control. *F. M. Blum, F. W. Wendelburg*, Harnischfeger Corporation

2:00 p.m. Land Transportation

48-300. Short-Time Ratings of Diesel-Electric Locomotives. *D. R. Campbell, T. J. Woods*, Westinghouse Electric Corporation

48-301. The Present Competitive Position of Coal, Residual Oil, Diesel Oil, and Electricity as Energy Sources for Motive Power Operation in the Pacific Northwest. *T. M. C. Martin*, Bonneville Power Administration

48-302. Head End Power on Railroad Passenger Trains. *H. H. Hanft*, Westinghouse Electric Corporation

48-303. Handling Suburban Traffic on Steam Railroads. *M. L. Sloman*, Westinghouse Electric Corporation

Friday, October 22

9:00 p.m. Switchgear

48-258. Simplified Calculation of Fault Currents. *Working group, switchgear committee*

48-248. A New Outdoor Air Switch and a New Concept of Contact Performance. *S. C. Killian*, Delta-Star Electric Company

48-304. High-Speed Reclosing of Power Circuit Breakers from a Manufacturer's Point of View. *H. B. Ashenden*, Allis-Chalmers Manufacturing Company

48-305. Large Indoor Power Air Blast Circuit Breakers. *G. E. Jansson*, Allis-Chalmers Manufacturing Company

48-306-ACO. Metalclad Switchgear with Air Blast Circuit Breakers.** *A. Ewy*, Allis-Chalmers Manufacturing Company

9:30 a.m. Conference on Automatic Contouring for Machine Tools

General paper:

CP.* Fundamentals of Machine Tool Contouring Systems. *J. M. Delfs*, General Electric Company

Individual papers by:

J. J. Jaeger, Pratt and Whitney Company
R. E. Schutte, Barber Colman Company
W. O. Osborn, Westinghouse Electric Corporation
R. D. McComb, General Electric Company

9:30 a.m. Switching Systems

48-312. Relay Preference Lockout Circuits in Telephone Switching. *A. E. Joel, Jr.*, Bell Telephone Laboratories, Inc.

CP.* The 7-J Rotary Telephone Switching Exchange. *R. W. Engsberg*, Federal Telephone and Radio Corporation

48-251. Military Teletypewriter Systems of World War II. *F. J. Singer*, Bell Telephone Laboratories, Inc.

48-317. Push-Button Switching in Telegraph Systems. *R. F. Blanchard, W. B. Blanton*, Western Union Telegraph Company

9:30 a.m. Joint Conference on Education and Student Branches

CP.* Career Breadth in Engineering. *T. G. LeClair*, Commonwealth Edison Company

CP.* Unsolved Problems in the Power Field. *A. C. Monteith*, Westinghouse Electric Corporation

CP.* Career Opportunities in the Utility Field. *F. E. Sanford*, Copper Wire Engineering Association

CP.* Better Methods and Stimulation of Teaching in the Power Field. *E. W. Boehne*, Massachusetts Institute of Technology

2:00 p.m. Relays

48-309. Voltage Surges in Relay Control Circuits *T. R. Halman, L. K. Harris*, Detroit Edison Company

48-310. Electronic Protective Relays. *R. H. Macpherson, A. R. VanC. Warrington, A. J. McConnell*, General Electric Company

48-260. A New Distance Ground Relay. *S. L. Goldsborough*, Westinghouse Electric Corporation

48-311. Instantaneous Bus-Differential Protection Using Bushing Current Transformers. *H. T. Seeley*, General Electric Company; *Frank von Roeschlaub*, Ebasco Services, Inc.

2:00 p.m. Conference on Automatic Contouring for Machine Tools (continued)

Papers by:

C. L. Calosi, Raytheon Manufacturing Company
P. M. Sampatacos, Consultant
A. H. Dall, Cincinnati Milling Machine Company
F. Fritzch and *C. M. Griffin*, Lodge and Shipley Company
Nagle Gusching, Monarch Machine Tool Company

2:00 p.m. Radio on Great Lakes

48-316-ACO. The Great Lakes Radiotelephone System.** *R. H. Herrick*, The Lorain County Radio Corporation

CP.* The Organization and Administration of Wide-Area Servicing Activities. *W. A. Goodell*, Lorain County Radio Corporation

CP.* Very-High-Frequency Radio on the Great Lakes. *C. M. Jansky, Jr.*, Jansky and Bailey

CP.* Three- and 10-Centimeter Commercial Marine Radar. *E. C. Kluender*, General Electric Company

AIEE Announces Changes in ELECTRICAL ENGINEERING Staff

G. Ross Henninger, editor of *ELECTRICAL ENGINEERING* since January 1, 1933, has resigned from the AIEE headquarters staff to assume the title of editor and director of publications for the Illuminating Engineering Society, New York, N. Y., effective October 1, 1948 (for complete biographical details, see page 1014). Appointed as *ELECTRICAL ENGINEERING*'s new editor to succeed Mr. Henninger is Charles S. Rich, who has been secretary of the AIEE technical program committee since 1930. Coincidental with these changes, W. R. MacDonald, Jr., associate editor, has resigned from the staff because of ill health. Biographical sketches of both Mr. Rich and Mr. MacDonald will appear in the November issue.

Mr. Henninger was brought to the headquarters staff in 1930 as associate editor of *ELECTRICAL ENGINEERING* to develop and put into effect the plans for an enlarged publication service which had been worked out by the publications committee. During the period from 1920 to 1930 the first efforts were made, as a result of exhaustive investigation by the publication committee, and in response to membership demands, to broaden the service to the reader by departing from the pre-1920 policy under which the monthly *PROCEEDINGS*, composed largely of verbatim reports of meetings, and the *TRANSACTIONS* served mainly as an outlet for technical material and as an archive. In 1920, the monthly publication became the larger sized *JOURNAL* devoted principally to abstracts of technical papers, and in 1931, as a result of continued dissatisfaction among the membership, *ELECTRICAL ENGINEERING* evolved as a service periodical whose aim was to reflect the more significant technical developments in general and interpretive terms.

Mr. Henninger assumed editorship of the magazine in 1933, at a time when the effects of the depression were being felt in the Institute as elsewhere. In the period 1934–37, the available annual publication budget hit a low of about $65,000 as compared with $118,000 in the early 1930's. As an indication of the greatly increased service that *ELECTRICAL ENGINEERING* is bringing to the reader today, the publication budget for the appropriation year 1947–48 was $246,000. In addition, the total annual number of pages has grown from 898 in 1932 to 1,270 for 1947, while *ELECTRICAL ENGINEERING*'s circulation for July 1948 was 45,000 as compared with a figure of 17,500 for the month of January 1934.

In an effort to reduce the total amount of material published, to meet 1934's greatly curtailed budget, and yet avoid reduction in the amount of new material made available to the general membership, a "unified publication program" was worked out in that year which eliminated as far as possible all "frills" and extra handling in order to achieve the lowest possible cost. To this end, all *TRANSACTIONS* papers, as well as various other material, were included in the monthly, and at the end of the year accumulated total pages were bound as the annual *TRANSACTIONS*, the simplest system mechanically as well as the least expensive. The total quantity of material distributed to the membership at large thus actually was increased rather than reduced. A feature of that period was that all technical papers were printed in advance of the meeting at which they were presented—the earliest publication with reference to presentation in the history of the Institute.

Beginning in 1938, in order to increase the proportion of general interest articles published, *ELECTRICAL ENGINEERING* was divided into two sections: one devoted to *TRANSACTIONS* papers and the other to general interest articles and news. An *ELECTRICAL ENGINEERING* Supplement" was introduced which contained those *TRANSACTIONS* papers not appearing in the monthly, making them available at a nominal price to members not subscribing to the *TRANSACTIONS* volumes.

The general features of this publication policy remained in effect until January 1947 when the publication committee announced the present publication plan, approved by the AIEE board of directors, under which the *TRANSACTIONS* section has been eliminated from *ELECTRICAL ENGINEERING* and in its stead a new series of publications, under the revived name of AIEE *PROCEEDINGS*, was established. This latest publication plan, which currently governs AIEE publication policy, was discussed in full in the December 1946 issue (*pages 576–8*). In essence it means that *ELECTRICAL ENGINEERING*, issued monthly to all members, now contains articles of general interest; all AIEE technical material in complete, condensed, or abstract form, depending upon scope and general interest of subject matter; and news of interest to AIEE members. AIEE *PROCEEDINGS*, distributed on individual request, contain full text of AIEE papers collated with their discussions. The AIEE *TRANSACTIONS*, issued following the end of each calendar year on advance order, contains in permanent bound form AIEE papers and discussions approved by the technical program committee and record material appropriately approved.

Southern District Meeting to Feature Industrial Renaissance of the South

A 3-day meeting of the Southern District will be held in Birmingham, Ala., November 3–5, 1948. Meeting headquarters will be in the Tutwiler Hotel. The tentative technical program is comprised of three technical sessions with papers on electronics, power, electrical applications, and other subjects of interest relating to the general theme which should prove highly instructive.

"Vulcan," largest iron man in the world and second largest statue in America, stands 53 feet tall mounted on a 120-foot pedestal atop Red Mountain overlooking Birmingham, Ala., site of the Southern District meeting. It typifies natural resources of the district, the only place in the world where coal, iron, and limestone, the three essentials for making steel, are found together in one mountain

INSPECTION TRIPS

Thursday and Friday afternoons will be devoted to inspection trips to local industries and other places of interest. Arrangements have been made for inspection of the tin plate mill and the hot strip mill of the Tennessee Coal, Iron, and Railroad Company on Thursday afternoon. This trip requires approximately three hours and those interested should assemble not later than 1:30 p.m. On Friday arrangements have been made for a party to see the experiment in underground gasification of coal being conducted by the United States Bureau of Mines and the Alabama Power Company at Gorgas, Ala. This trip requires approximately six hours and those interested should assemble not later than 12:00 noon.

On Thursday and Friday afternoons parties will be organized to visit the laboratories of the Southern Research Institute, the 110-kv oilostatic cable installation of the Birmingham Electric Company, and Radio Center atop Red Mountain, where amplitude modulation, frequency modulation, and television broadcasting equipment is in service or being installed. A charge of $1 will be made for each inspection trip.

Tentative Technical Program

Southern District Meeting, Birmingham, Ala., November 3–5, 1948

Wednesday, November 3

8:30 a. m. Registration

10:00 a.m. Opening Session

H. J. Scholz, presiding

Address of Welcome: The Honorable Cooper Green, President of City Commission

Remarks: Conference General Chairman F. C. Weiss

Remarks: Vice-President J. H. Berry

Address: "Our Institute." President Everett S. Lee

2:00 p.m. Technical Session

L. M. Smith, presiding

DP.* Southern Bell Applies Electronics. *J. D. Askew*, Southern Bell Telephone and Telegraph Company

48-262. Carrier Channels for Telemetering. *T. DeWitt Talmage*, Tennessee Valley Authority

DP.* A Load Control Installation in the South. *T. H. Mawson*, Commonwealth and Southern Corporation

DP.* Installation, Operation, and Maintenance of 2-Way Radio. *Blair Jenkins, Jr.*, Caroline Power and Light Company

DP.* A Linear Analysis of a Tuned Plate Oscillator. *Craig Harris*, University of Tennessee

DP.* The Operational Amplifier. *Nicholas J. Gagliano*, Tulane University

5:30 p.m. Social Hour

7:00 p.m. Banquet (Women Invited)

C. S. Thorn, presiding

Address: "Industrial Research in the South." Thomas W. Martin, President, Alabama Power Company

Thursday, November 4

9:00 a.m. Technical Session

E. W. Robinson, presiding

DP.* Sectional Paper Machine Drives. *V. B. Baker, E. H. Vedder*, Westinghouse Electric Corporation

***DP.** District paper; no advance copies are available; not intended for publication in *TRANSACTIONS*.

—PAMPHLET reproductions of author's manuscripts of the numbered papers listed in the program may be obtained as noted in the following paragraphs.
—PRICES for papers, irrespective of length, are 30 cents to members (60 cents to nonmembers) whether ordered by mail or purchased at the meeting. Mail orders are advisable, particularly from out-of-town members, as an adequate supply of each paper at the meeting cannot be assured. Only numbered papers are available in pamphlet forms.
—COUPON books in five-dollar denominations are available for those who may wish this convenient form of remittance.
—THE PAPERS regularly approved by the technical program committee ultimately will be published in PROCEEDINGS and TRANSACTIONS; also, each is scheduled to be published in ELECTRICAL ENGINEERING in digest or other form.

DP.* Unit Substations for Modern Power Distribution. *D. E. Straley*, General Electric Company

DP.* Heavy Electric Equipment as Applied to the Tennessee Coal, Iron, and Railroad Company. *W. W. Garrett, Jr.*, Tennessee Coal, Iron, and Railroad Company

D.P.* Recent Developments in Power Transformers. *Gordon W. Clothier*, Allis-Chalmers Manufacturing Company

DP.* Modern Developments in High-Voltage Transmission Cable. *R. P. Lapsley*, The Okonite-Callender Cable Company

DP.* Electric Mass Transportation. *John Gerson*, Georgia Power Company

DP.* Electrostatic Air Cleaning in the Textile Industry. *R. P. Posey, C. H. McWhirter*, Westinghouse Electric Corporation

1:30 p.m. Inspection Trips

Radio Center

Southern Research Institute

Underground coal gasification experiment of the United States Bureau of Mines and the Alabama Power Company

7:00 p.m. Banquet]

J. H. Berry, presiding

Address: "The Southern College and Southern Industry." Doctor John M. Gallalee, president, University of Alabama

Friday, November 5

9:00 a.m. Technical Session

William J. Miller, presiding

DP.* Electrical Engineering for Atomic Energy. *D. W. Cardwell*, Oak Ridge National Laboratories

48-318. Causes and Effects of Stray Electric Currents in Coal Mines. *L. H. Harrison*, United States Bureau of Mines

DP.* Electricity Is an Integral Part of Agriculture. *W. J. Ridout, Jr.*, Edison Electric Institute

DP.* Potential Gradients Within and Around Substation Ground Fields. *C. C. Jones, C. R. Jager*, Alabama Power Company

DP.* Electricity Serves the Construction Industry. *D. B. Clayton*, Knight Electric Company

DP.* The Specialty End of the Electrical Manufacturing Industry. *Gordon Berry*, Electric Products Company

12:00 m. Inspection Trips

Radio Center

Southern Research Institute

Tennessee Coal, Iron, and Railroad Company hot strip and tin plate mills 110-kv oilostatic cable installation of Birmingham Electric Company

110-kv Oilostatic cable installation of Birmingham Electric Company

ENTERTAINMENT

On Wednesday evening at 5:30 p.m. there will be a social hour followed at 7:00 p.m. by a banquet at the Tutwiler Hotel. The women are invited.

On Thursday evening at 7:00 p.m. there will be a banquet at the Tutwiler Hotel for men only (a separate meeting is scheduled at this same time for women visitors). There will be a charge of $5 per plate for each of these banquets.

It would be of considerable help to the committees planning these entertainments if those planning to attend these two banquets would so indicate on their advance reservation card.

WOMEN'S ENTERTAINMENT

A full program of entertainment will be provided for visting women. On Wednesday there will be a sightseeing trip of the city with a luncheon at the Birmingham Country Club, and a social hour and banquet Wednesday evening at the Tutwiler Hotel.

On Thursday there will be a luncheon at the Mountain Brook Club followed by bridge or golf for those women desiring to play, and a banquet at the Molton Hotel for women only at 7:00 p.m.

On Friday morning arrangements have been made for inspecting the plant of the Bradford-Norton Millinery Company. Women also are invited to attend any of the inspection trips arranged for the men. A charge of $1 will be made for each luncheon and the Thursday evening banquet. This will cover any inspection trip or activity associated with the luncheon.

It would be very helpful to the committee arranging for the women's entertainment if advance reservation cards would indicate the number of women planning to attend.

SPORTS

For those who so desire, arrangements can be made for golf at several excellent courses, skeet or trap shooting at a sky-line course, tennis, or riding.

HOTEL RESERVATIONS

Members of the Southern District who will attend the meeting should make reservations by filling in and mailing the advance registration and hotel reservation card as soon as received. Arrangements have been made with the principal hotels in Birmingham for a sufficient number of rooms at regular commercial rates for the estimated attendance, but due to the unsual demand for accommodations for week ends during the football season, it will be necessary to release any unused accommodations three days prior to the meeting. Unless specifically arranged otherwise, rooms must be vacated by 6:00 p.m. on Friday, November 5. Special low-cost accommodations will be available for a limited number of students. Meeting headquarters will be in the Tutwiler Hotel. All other hotels are within walking distance.

ADVANCE REGISTRATION

In order to save time and to assist the various committees in arranging for the accom-

Future AIEE Meetings

Middle Eastern District Meeting
Hotel Statler, Washington, D. C.
October 5–7, 1948
(*Final date for submitting papers—closed*)

Midwest General Meeting
Schroeder Hotel, Milwaukee, Wis.
October 18–22, 1948
(*Final date for submitting papers—closed*)

Southern District Meeting
Birmingham, Ala.
November 3–5, 1948
(*Final date for submitting papers—closed*)

AIEE/IRE Conference on Electronic Instrumentation in Medicine and Nucleonics
Engineering Societies Building
New York, N. Y.
November 29–December 1, 1948

AIEE Conference on the Textile Industry
Atlanta, Ga.
Fall, 1948

AIEE Conference on Electric Welding
Engineering Society of Detroit Building
Detroit, Mich.
December 6–8, 1948

AIEE Conference on High-Frequency Measurements
National Bureau of Standards,
Washington, D. C.
January, 1949

Winter General Meeting
Pennsylvania Hotel, New York, N. Y.
January 31–February 4, 1949
(*Final date for submitting papers—November 16*)

AIEE Conference on the Textile Industry
Boston, Mass.
Spring, 1949

AIEE Conference on Electron Tubes
March, 1949

AIEE Conference on the Rubber and Plastics Industry
Akron, Ohio
March, 1949

South West District Meeting
Dallas, Tex.
April 19–21, 1949

Summer General Meeting
New Ocean House, Swampscott, Mass.
June 20–24, 1949

Pacific General Meeting
Fairmont Hotel, San Francisco, Calif.
August 23–26, 1949

Midwest General Meeting
Cincinnati, Ohio
October 17–21, 1949

AIEE Conference on Industrial Power Distribution
Date to be announced

Laboratory scene at the Southern Research Institute which may be inspected by AIEE members attending the Southern District meeting in Birmingham, Ala.

modation and entertainment of those who attend, space has been provided on the registration and reservation card for pertinent information, which will be sent to the members in the Southern District. These cards should be filled out and mailed to the committee chairman, J. W. Graff, 600 North 18th Street, Birmingham 3, Ala. Registration fee will be $2 for members and $3 for nonmembers. Everyone attending or participating will be requested to register, but no charge will be made for students and families of Institute members.

COMMITTEES

The chairmen of the committees making arrangements for the meetings are as follows:

F. C. Weiss, *general chairman;* E. W. Robinson, *cochairman;* C. S. Thorn, *finance;* J. W. Graff, *hotel and reservation;* L. M. Smith, *technical papers and program;* W. H. Hassinger, Jr., *entertainment and sports;* E. R. Coulbourn, *attendance and publicity;* A. G. Morton, *transportation and inspection;* W. J. Miller, *Student activities;* Mrs. T. H. Mawson, *ladies' program.*

Early Hotel Reservations Urged for Winter Meeting

As announced on page 781 of the August issue of *ELECTRICAL ENGINEERING*, the 1949 AIEE winter general meeting will be held in New York, N. Y., during the week of January 31 through February 4, 1949. Meeting headquarters will be at the Pennsylvania Hotel with all activities centered at that hotel, except for the smoker.

The technical program probably will consist of 50 to 55 technical sessions and conferences, but this program will not be completed until some time this Fall. An interesting series of inspection trips is being planned as closely correlated with the technical sessions as possible. Plans also are now underway for both a smoker and a dinner-dance. Particular attention is called to the fact that it has been necessary to reverse the nights on which these affairs have been staged in the past—the dinner-dance will be given at the Pennsylvania Hotel on Tuesday night, February 1, 1949, and the smoker at the Commodore Hotel on Thursday night, February 3, 1949. The prices of the tickets have not been settled as yet. An extensive program of entertainment for the women attending the meeting is under development. For the accommodation particularly of the members from out-of-town, blocks of theater tickets for popular shows will be available for sale in advance of the meeting.

REGISTRATION FEES

To defray the expenses incurred by the Institute in the holding of meetings, the board of directors has ruled that future meetings must be placed on a substantially self-supporting basis. In view of this action, registration fees will be in force for both members and nonmembers. These fees will be announced at a later date.

HOTEL RESERVATIONS

As it is believed those attending the 1949 meeting from out-of-town will want rooms at the headquarters hotel, the winter general meeting committee has reserved a large number of rooms. The committee urges all those who will require rooms to make their reservations at the earliest possible date by writing directly to the Pennsylvania Hotel, 7th Avenue and 33d Street, New York, N. Y., mentioning that the reservation is in connection with the AIEE winter meeting during week beginning January 31, 1949. A copy of the letter also should be sent to Robert T. Oldfield, Public Service Commission, 233 Broadway, New York 7, N. Y. This latter requirement is important as it will avoid confusion and insure a definite reservation of space required.

AIEE Forms Section at Richland, Wash.

H. R. Hughes of the Hanford Engineer Works, Richland, Wash., was installed as the first chairman of the AIEE Richland Section, at the Section's inaugural meeting on August 23, 1948. The installation of officers shared the spotlight with a talk by AIEE President Everett S. Lee.

Other new officers of the Richland Section are

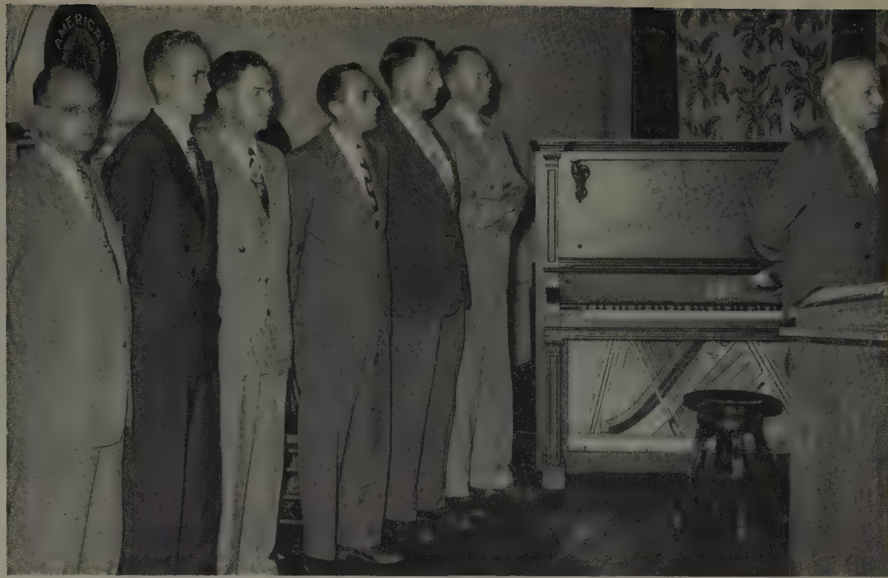
W. J. Dowis, *vice-chairman;* J. H. Hemperly, *secretary-treasurer;* F. E. Johnson, M. H. Arndt, F. J. Mollerus, and R. B. Crow, *executive committee members.*

Committee chairmen are

I. M. A. Garcia, *membership;* R. B. Crow, *program;* W. J. Dowis, *educational;* H. A. Carlberg, *technical;* R. C. Hoffman, *publicity.*

Owen W. Hurd, chairman of the AIEE, Spokane Section formally installed the officers of the Richland Section.

C. F. Terrell, retiring vice-president of District 9 (North West) introduced Mr. Lee who discussed the "Value of AIEE to Engineers and Engineering Friendships."



Being installed as officers at the inaugural meeting of the new AIEE Richland (Wash. Section are (left to right) R. B. Crow, executive committee member; J. H. Hemperly. secretary-treasurer; H. R. Hughes, chairman; W. J. Dowis, vice-chairman; F. E., Johnson, executive committee member; and M. H. Arndt, executive committee member. Presiding at the installation is O. W. Hurd, chairman of the AIEE Spokane Section

Mr. Lee declared:

If all people understood the laws governing human relations as well as engineers and scientists understand natural laws, there would be no more war. Wherever I have talked to scientific people, of whatever nation, they have deplored the world situation.

Before the last war, a co-ordinated effort to establish uniform standards of electrical measurements was stopped because of Hitler's aggressive plans. There were tears in the eyes of the German scientists when they told us they couldn't work with us any longer.

Mr. Lee urged electrical engineers to tell the public about their profession and its achievements, to join chambers of commerce and other civic groups, to take an active interest in schools and community affairs.

Engineers have been involved in the creation of every useful material thing. The people should be told the story of the engineers' part in this creation.

Attending the luncheon meeting featured as part of the AIEE Richland (Wash.) inaugural program are (left to right, around table) Earl Peabody, chairman, committee on arrangements; C. F. Terrell, retiring vice-president, District 9; E. W. Seckendorff; H. A. Carlberg, chairman of Richland Section technical committee; J. H. Hemperly, secretary-treasurer, Richland Section; W. J. Dowis, vice-chairman Richland Section; Floyd Bay; Joe Robinson; R. B. Crow chairman, program committee and member of executive committee, Richland Section; Gray Clifton; L. B. Robinson; E. S. Lee, AIEE president; H. H. Henline, AIEE secretary; H. R. Hughes, chairman, Richland Section

He said that the AIEE, with 30,000 members in the United States, is the nation's largest engineering society. There are about 75 members in the Richland Section, which is the 83d chartered Section of the AIEE.

The Richland Section now includes five counties in Washington and one in Oregon; namely: Umatilla County, Oreg.; and, Benton, Columbia, Franklin, Walla Walla, and Yakima Counties, Wash., which were orginally parts of the areas assigned to the Spokane and Portland Sections.

Official guests were David Shaw, deputy manager for Hanford directed operations, Atomic Energy Commission; G. G. Lail, manager of the service divisions and assistant to the manager of the nucleonics department, General Electric Company; H. H. Henline, secretary of the AIEE; C. F. Terrell, retiring District vice-president, District 9, and vice-president of the Puget Sound Power and Light Company; M. M. Ewell, chairman of the Portland Section, and service engineer of the Westinghouse company's Portland Branch; Owen W. Hurd, chairman of the Spokane Section, and manager of Benton County Public Utilities Department; and L. B. Robinson, representing the Seattle Section, and district transformer engineer for General Electric Company's Seattle, Wash., branch.

The dinner meeting at the Legion Hall, which was attended by the members and their wives, followed a luncheon for officers and guests of the AIEE at the Desert Inn, and a conducted tour of the constuction areas with entertainment in private homes for the women. The inaugural dinner meeting was attended by 168 guests and members. E. P. Peabody was chairman of the committee in charge of the arrangements for this meeting.

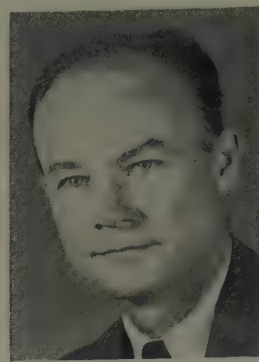
Introducing AIEE Section

Some of the men who will preside over AIEE Sections during 1948-49;

C. R. Reid
(*Akron Section*)

H. J. Scholz
(*Alabama Section*)

C. M. Hart
(*Arizona Section*)

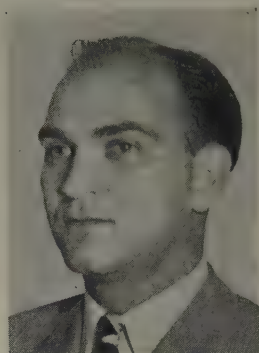


H. W. Claybaugh
(*Arkansas Section*)

R. L. Boisen
(*Arrowhead Section*)

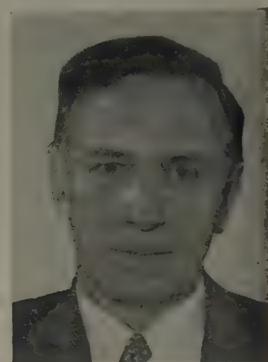
A. L. Howell
(*Beaumont Section*)

F. B. Haeussler
(*Boston Section*)



D. C. Krammes
(*Canton Section*)

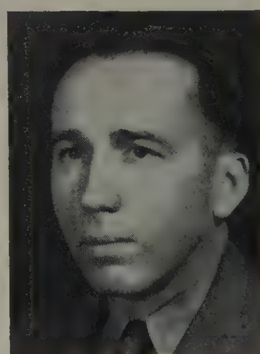
F. D. Troxel
(*Chicago Section*)



J. D. Leitch
(*Cleveland Section*)

C. W. Mayott
(*Connecticut Section*)

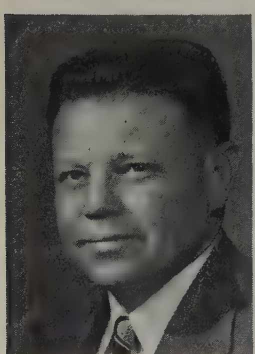
W. R. Appleman
(*Dayton Section*)



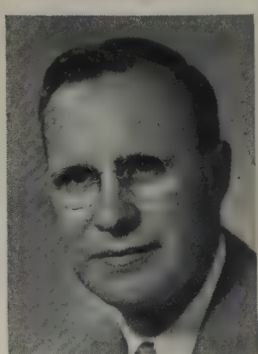
C. L. Reed, Jr.
(*Erie Section*)

C. J. Herman
(*Fort Wayne Section*)

R. O. Loomis
(*Georgia Section*)



H. C. Dillingham
(*Houston Section*)



W. J. Johnson
(*Illinois Valley Section*)

J. E. Murray
(*Kansas City Section*)

Bradley Cozzens
(*Los Angeles Section*)

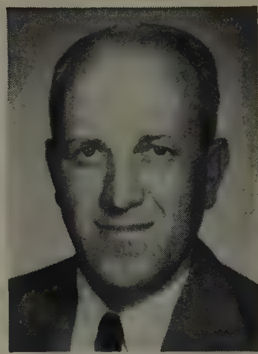
M. G. Northrop
(*Louisville Section*)

Chairmen for 1948-49

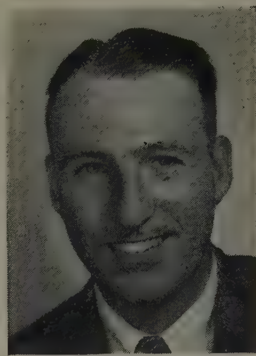
others will appear in the November issue

R. G. Slauer
(*Lynn Section*)

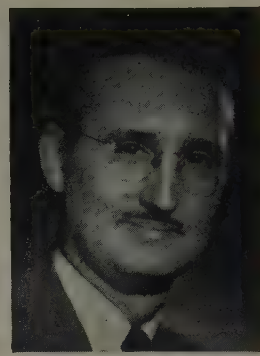
L. F. Kehoe
(*Madison Section*)



R. L. McCoy
(*Maryland Section*)

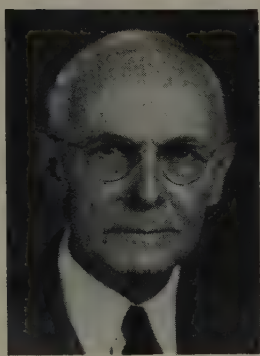


M. R. Horne
(*Michigan Section*)



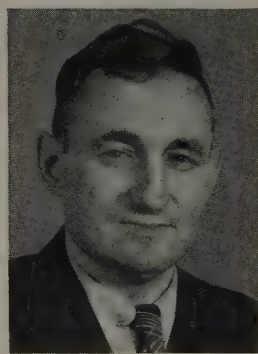
E. T. Sherwood
(*Milwaukee Section*)

H. P. Bruncke
(*Minnesota Section*)



O. F. Metz
(*New Mexico–W. Texas Sec.*)

R. T. Oldfield
(*New York Section*)



J. E. Sowers
(*Niagara Frontier Section*)

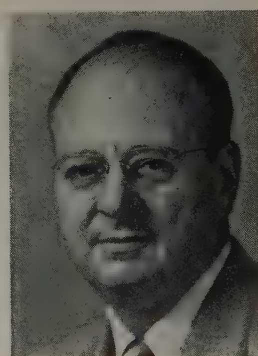
C. G. Brennecke
(*North Carolina Section*)

J. M. Hagler
(*North Texas Section*)

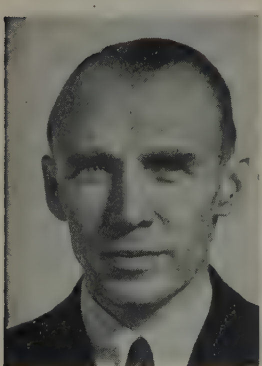
R. F. McClure
(*Panhandle Plains Section*)

A. P. Godsho
(*Philadelphia Section*)

H. H. Wagner
(*Pittsburgh Section*)



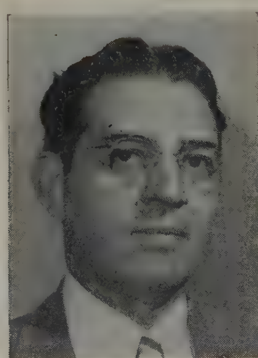
H. S. Hubbard
(*Pittsfield Section*)



M. M. Ewell
(*Portland Section*)

H. R. Hughes
(*Richland Section*)

C. G. Plomasen
(*Rochester Section*)



R. W. Gaskins
(*St. Louis Section*)

H. A. Cordes
(*San Diego Section*)

AIEE Officers to Be Nominated for 1949 Election

For the nomination of officers to be voted upon in the spring of 1949, the AIEE nominating committee will meet in New York, N. Y., in January 1949. The officers to be elected are: a president, a treasurer, three directors, and five vice-presidents, one from each of the even-numbered geographical Districts. Fellows only are eligible for the offices of president, and Members and Fellows for the offices of vice-president, director, and treasurer.

To guide this committee in performing its constituted task, suggestions from the membership are, of course, highly desirable. To be available for the consideration of the committee, all such suggestions must be received by the secretary of the committee at Institute headquarters, not later than December 15, 1948.

In accordance with the provisions in the constitution and bylaws, quoted in the following paragraphs, actions relating to the organization of the nominating committee are now under way.

Constitution

28. There shall be constituted each year a Nominating Committee consisting of one representative of each geographical District, elected by its executive committee, and other members chosen by and from the Board of Directors not exceeding in number the number of geographical Districts; all to be selected when and as provided in the bylaws. The secretary of the Institute shall be the secretary of the Nominating Committee, without voting power.

29. The executive committee of each geographical District shall act as a nominating committee of the candidate for election as vice-president of that District, or for filling a vacancy in such office for an unexpired term, whenever a vacancy occurs.

30. The nominating Committee shall receive such suggestions and proposals as any member or group of members may desire to offer, such suggestions being sent to the secretary of the committee.

The Nominating Committee shall name on or before January 31 of each year, one or more candidates for president, treasurer, and the proper number of directors, and shall include in its ticket such candidates for vice-presidents as have been named by the nominating committees of the respective geographical Districts, if received by the Nominating Committee when and as provided in the bylaws; otherwise the Nominating Committee shall nominate one or more candidates for vice-president(s) from the District(s) concerned.

By laws

Sec. 21. During September of each year, the secretary of the Nominating Committee shall notify the chairman of the executive committee of each geographical District that by December 15 of that year the executive committee of each district must select a member of that District to serve as a member of the Nominating Committee, and shall by December 15, notify the secretary of the Nominating Committee of the name of the members elected.

During September of each year, the secretary of the Nominating Committee shall notify the chairman of the executive committee of each geographical District in which there is or will be during the year a vacancy in the office of vice-president, that by December fifteenth of that year a nomination for a vice-president from that District, made by the District executive committee, must be in the hands of the secretary of the Nominating Committee.

Between October first and December fifteenth of each year, the Board of Directors shall choose five of its members to serve on the Nominating Committee and shall notify the secretary of that committee of the names so selected and shall also notify the five members selected.

The secretary of the Nominating Committee shall give the fifteen members so selected not less than ten days' notice of the first meeting of the committee, which shall be held not later than January thirty-first. At this meeting, the committee shall elect a chairman and shall proceed to make up a ticket of nominees for the offices to be filled at the next election. To insure that full consideration be given to all suggestions from the general membership, they must be in the hands of the secretary of the committee by December fifteenth. The nominations as made by the Nominating Committee shall be published in the March issue of *Electrical Engineering*, or otherwise mailed to the Institute membership not later than the first week in March.

INDEPENDENT NOMINATIONS

Independent nominations may be made in accordance with provisions in article VI, section 31, of the constitution and section 23 of the bylaws, which are quoted below:

Constitution

31. Independent nominations may be made by a petition of twenty-five (25) or more members sent to the secretary when and as provided in the bylaws; such petitions for the nomination of vice-presidents shall be signed only by members within the District concerned.

By laws

Sec. 22. Petitions proposing the names of candidates as independent nominations for the various offices to be filled at the ensuing election, in accordance with article VI, section 31 (constitution), must be received by the secretary of the Nominating Committee not later than March 25 of each year, to be placed before that committee for the inclusion in the ballot of such candidates as are eligible.

On the ballot prepared by the Nominating Committee in accordance with article VI of the constitution and sent by the secretary to all qualified voters on or before April 15 of each year, the names of the candidates shall be grouped alphabetically under the name of the office for which each is a candidate.

(*Signed*) H. H. Henline,
Secretary

AIEE Board of Directors Holds Regular Meeting

A regular meeting of the AIEE board of directors was held at Institute headquarters, New York, August 5, 1948.

The minutes of the meeting of the board of directors held June 24, 1948, were approved.

Report was made of executive committee action on applications as of July 7, 1948, as follows: 12 applicants transferred to the grade of Fellow, 61 applicants transferred to the grade of Member.

Recommendations adopted by the board of examiners at a meeting held July 15, 1948, were reported and approved. The following actions were taken upon recommendation of the board of examiners: 23 applicants were transferred to the grade of Fellow; 1 Fellow was reinstated; 61 applicants were transferred and 23 were elected to the grade of Member; 490 applicants were elected to the grade of Associate; 191 Student members were enrolled.

Disbursements in July 1948 from general funds, amounting to $81,277.91, were reported and approved.

NIAGARA FALLS SECTION

Upon petition of members in the Niagara Falls Subsection of the Niagara Frontier Section and the Niagara Subsection of the Toronto Section for full Section status, the directors authorized the establishment of Niagara Falls Section, with territory consisting of Niagara County, N. Y., and Lincoln and Welland Counties, Ontario, Canada, and referred the question of District affiliation of the new Section to the Sections committee for recommendation as to whether it should be a part of the North Eastern District (1) or Canada District (10).

Upon recommendation of the Sections committee, the directors authorized the usual allowance for travel expense of the chairman and the secretary of the Sections committee to the summer general meeting.

Dates of June 12–16 were approved for the 1950 summer and Pacific general meeting to be held in Pasadena, Calif., with headquarters in the Huntington Hotel.

REGISTRATION FEES

Further consideration was given to the subject of meeting registration fees, and the following action was taken, superseding action of the board of directors in April 1948:

Voted that, beginning with the 1948 Midwest general meeting, registration fees shall be charged at Institute meetings as follows:

District meetings:

Members	$2
Nonmembers	3
Student members and families of members	No fee

General meetings:

Members	$3
Nonmembers	5
Student members and families of members	No fee

The funds from both member and nonmember fees to be remitted to Institute headquarters.

The directors approved a statement of administrative scope of the technical co-ordinating committees as recommended by the committee on planning and co-ordination.

APPOINTMENTS

The Standards committee reported the appointment of the following Institute representatives:

On AIEE delegation on sectional committee *C50* "Rotating Electric Machinery:" C. L. Killgore, S. H. Mortensen, and V. E. Schlossberg, members of the delegation. and J. E. Clem, alternate.

On divisions of the electrical Standards committee of the American Standards Association: Division on power—W. P. Dobson, H. E. Farrer, and E. B. Paxton Division on communications and electronics—F. E Harrell, Reginald L. Jones, and J. J. Pilliod.

As required by the bylaws of the committee, the directors confirmed the appointment by the President of D. I. Cone, John B. MacNeill, and Philip Sporn as members of the Edison Medal committee for the 5-year term beginning August 1, 1948, and the appointment of A. E. Knowlton as chairman of the committee for the administrative year 1948-49; and elected from its own membership as members of the committee for the 2-year term beginning August 1, 1948, R. T. Henry, M. D. Hooven, and Victor Siegfried.

The directors approved the appointment by the president of J. W. Barker and Roger I. Wilkinson as members of the Charles LeGeyt Fortescue Fellowship committee for the term of three years, and of J. H. Berry, T. H. Morgan, and L. A. Umansky as members of the Lamme Medal committee for the 3-year term beginning August 1, 1948.

The standing representatives of the Institute were appointed for the administrative year beginning August 1, 1948.

The directors accepted an invitation to appoint two AIEE representatives on the Inter-Society Corrosion Committee of the National Association of Corrosion Engineers. This committee will carry on the useful functions of the American Co-ordinating Committee on Corrosion, recently disbanded. L. J. Gorman and H. M. Trueblood were appointed.

Local Honorary Secretaries of the Institute were reappointed for the 2-year term beginning August 1, 1948, as follows:

Australia—V. J. F. Brain
Northern India—S. S. Kumar

Southern India—S. M. Zubair
Transvaal—Francis E. Ingham

The president was empowered to appoint an AIEE representative to attend a conference, in London, October 4–8, 1948, of representatives from engineering societies of Western Europe and the United States of America.

The president was empowered to appoint a committee of one or more to co-operate with the Institute of Radio Engineers in the preparation of a plan of operation of joint AIEE-IRE Student Branches.

In the belief that the Institute has grown to the point where it is no longer reasonable to expect the president to visit Sections as heretofore, the board of directors adopted a resolution to this effect and suggesting visits by the vice-presidents in his place, the Sections to be notified accordingly.

It was decided to hold the next meeting of the board of directors in Milwaukee, on October 19, during the Midwest general meeting of the Institute.

Other matters were discussed, reference to which may be published in this or future issues of *ELECTRICAL ENGINEERING.*

Present at the meeting were

President—Everett S. Lee, Schenectady, N. Y.

Vice-Presidents—J. H. Berry, Norfolk, Va.; G. W. Bower, Haddonfield, N. J.; J. L. Callahan, New York, N. Y.; D. I. Cone, San Francisco, Calif.; I. M. Ellestad, Omaha, Nebr.; D. G. Geiger, Toronto, Ontario, Canada; G. N. Pingree, Dallas, Tex.; Victor Siegfried, Worcester, Mass.; I. A. Terry, Fort Wayne, Ind.

Directors—W. L. Everitt, Urbana, Ill.; J. F. Fairman, New York, N. Y.; C. W. Fick, Cleveland, Ohio; J. M. Flanigen, Atlanta, Ga.; R. T. Henry, Buffalo, N. Y.; M. D. Hooven, Newark, N. J.; F. O. McMillan, Corvallis, Oreg.; A. C. Monteith, East Pittsburgh, Pa.; J. R. North, Jackson, Mich.; Elgin B. Robertson, Dallas, Tex.; Walter C. Smith, Palo Alto, Calif.; E. P. Yerkes, Philadelphia, Pa.

Treasurer—W. I. Slichter, New York, N. Y.

Secretary—H. H. Henline, New York, N. Y.

Co-ordinating Committee Scope Announced for Technical Group

At its regular meeting in New York, N. Y., on August 5, 1948, the AIEE board of directors approved the following statement of administrative scope for technical co-ordinating committees which was prepared by M. J. Steinberg, chairman, technical activities subcommittee, and approved by the planning and co-ordinating committee on August 4, 1948.

The technical co-ordinating committee shall

1. Serve as the agency of the technical committees within the co-ordinating group to co-ordinate the activities of such committees.

2. Recommend to the president for appointment chairmen and members of technical committees within the co-ordinating group.

3. Recommend to the board of directors the formation of new technical committees within its field of technical activity or the abandonment of committees no longer considered essential.

4. Assign to one technical committee within the co-ordinating group administrative jurisdiction of joint subcommittees, working or project committees jointly representing two or more technical committees within the group.

5. Assign jurisdiction of technical subjects within the scopes of the committees within the co-ordinating group and make changes of the appropriate technical committee scopes as may be necessary to effect such jurisdiction.

6. Recommend to the board of directors joint activities with technical committees of other societies.

7. Co-operate with other co-ordinating committees in arranging for joint participation in activities of mutual interest.

8. Assist the technical program committee in formulating programs for general and District meetings.

9. Exercise administrative jurisdiction of technical conferences sponsored by technical committees within the co-ordinating group, and clear details of programs with technical program committee to avoid conflict with general and District meetings.

10. Initiate, independently or at the request of the Standards committee, technical studies required for the preparation of Institute Standards and recommended practices.

11. At the request of the Standards committee, assist in the preparation of Institute Standards and recommended practices.

Pacific General Meeting Brings Engineering Achievements to Fore

Spokane, Wash., was host to the Pacific general meeting held August 24–27, 1948, with headquarters in the Davenport Hotel. Papers were presented in seven technical sessions which were in keeping with the trend of the times toward larger and larger blocks of power as well as higher and higher transmission voltages and the contributions were particularly appropriate to the area of the Pacific Northwest. The general session was held following the opening of the meeting and there were two student sessions in which papers were presented by the students. On the social side, there was a president's reception, banquet, and a special program of events for the women. Important luncheon meetings with civic groups were held each day which afforded an opportunity to acquaint those in daily life with the achievements of electrical engineers. A meeting of the District 9 (Northwest) executive committee and a special meeting of District and Section officers of Districts 8 (Pacific) and 9 were held on succeeding days. The golf tournament was played on Thursday afternoon and there were alternate inspection trips to the aluminum reduction plant at Mead or the aluminum rolling mill at Trentwood. Friday was devoted to an all-day trip to the Grand Coulee Dam, power plant, and switchyard, with the option of an alternate trip to the Bunker Hill and Sullivan Mining and Concentrating Company at Kellogg, Idaho. Attendance at the meeting, including members, guests, and students numbered 375.

OPENING MEETING AND GENERAL SESSION

The meeting was opened on Tuesday morning by Richard McKay, vice-president of the North West District, who stated that the primary purpose of the occasion was the technical development of the art supplemented by the trips and social functions. An interesting comparison of progress in the electrical industry of the Pacific Northwest was drawn between the time when Spokane was host to its first AIEE meeting in 1914 and the present. At that time, in the Spokane area, there were only the Little Falls plant of 20,000 kw and one or two smaller generating stations. Power transmission was at 60,000 volts for a distance of 100 miles without any interconnections as compared with the vast interconnection of today between ten major systems in the states of Washington, Idaho, Montana, Utah, and Oregon spanning a distance in excess of 1,000 miles. The largest industrial loads were in the order of 1,000 kw principally for mining, whereas today there is the aluminum reduction plant at Mead of 235,000 kw. In 1914, there were two telephone companies in Spokane giving satisfactory service, but transcontinental telephone service and atomic energy were unknown. In conclusion, Mr. McKay on behalf of the Mayor of Spokane extended a welcome to members and guests and asked that they make their wishes known to the committee. C. F. Terrell responded briefly commenting on the splendid program of timely subject matter and the size of the Hanford Works which was visited preceding the installation of the new Richland Section.

"OUR INSTITUTE"

The meeting was addressed by President Lee whose subject was "Our Institute" (*EE, Sep '48, p 777*). Among the topics discussed, the importance of engineering friendships was stressed, membership growth was considered, and the desire for professional recognition particularly among the younger engineers was emphasized.

In regard to friendships President Lee spoke from personal experiences referring to the opportunities for friendship within the Institute. He attributed his growth in the profession in no small measure to engineering friendships. Friendships at home and in the community are a large contributing factor in daily living.

With respect to the growth in membership, President Lee explained that the membership at present was approximately 30,000 with 9,985 enrolled students. As the student enrollment of last April was about 13,000 he predicted that the number of enrolled students would be 15,000 when the colleges get in full swing. "We are now the largest engineering society in the world." What is our potential? In general terms there are about 60,000 electrical engineers in the United States so that for every member there is a nonmember. Officers and representatives of the Sections present were asked to take that back with them to the chairmen of their membership committees.

In conclusion, President Lee stated that not enough attention had been given to engineers and in particular the young engineers. In general, in the future, engineers will have to give some of their time to bring engineering achievements to the attention of other people. He was happy that the program committee had arranged for the opportunities to talk to the various civic groups and explained that he would address the Spokane Chamber of Commerce luncheon on "What We Have Done Together."

LONG-RANGE PLANNING FOR POWER SUPPLY

An address, "Long-Range Planning for Power Supply," was given by F. O. McMillan, AIEE director and dean of engineering, Oregon State College. A comprehensive study of the many factors involved;

population growth, trends in the electrification of industry, residential and rural electrification, installed generating capacity, electric energy generated, sources of energy for power generation, the energy reserves for future development, and the utility physical plant were taken into consideration with some of the trends shown by slides of curves. The trend in transmission voltages and the importance of the distribution plant were analyzed in relation to the rapidly depleting copper supplies and the economics of these problems. The analysis lead to conclusions as follows:

1. National changes in population probably will be of the order of ten per cent or less per decade.

2. Regional changes in population are large in some areas amounting to more than 40 per cent in eight years.

3. Power used per industrial worker is growing rapidly and may reach ten horsepower by 1960.

4. Residential and rural use of energy is growing rapidly with no end of saturation because the use in some areas is two or more times the national average.

5. Load growth indicates that the 1947 generating capacity may have to be doubled in 1960.

6. The percentages of fuel and hydro have remained quite constant over the years and are now 70 per cent fuel and 30 per cent hydro.

7. The electric energy generated is increasing in a very rapid rate having more than doubled in a decade from 1937–47.

8. The only sources of energy now available are water power, coal, crude oil, natural gases.

9. Improvements in the thermal efficiencies of boilers and turbines since 1920 have had a marked effect on the total energy requirements.

10. The feasible hydroelectric reserve in the United States probably will be developed completely in the next 30 to 40 years. The Pacific Northwest reserve may be developed in as short a period as 20 years.

11. Coal will continue to be the most important single resource for the future development of power until atomic energy or some other source of energy not now used is developed.

12. The United States has one-half he coal reserves of the world. These reserves are su cient to last 3,100 years at the maximum annual use attained to date.

13. The gassification of coal in place gives promise of eliminating mining losses and effecting a material reduction in the cost of extracting the energy from coal without removing it from the natural beds.

14. Transmission voltages probably will go to higher values but we appear to be reaching the point of diminishing returns from an economic standpoint.

15. A distribution plant needs more engineering and new ideas to reduce investment and improve efficiency.

16. The national copper supply is approaching depletion. The known copper reserves are of low grade ore and high prices or subsidies have been necessary to stimulate production. The rate of consumption in 1948 indicates that the annual copper deficit will be of the order of 500,000 tons.

SPOKANE CHAMBER OF COMMERCE LUNCHEON MEETING

Members and guests were invited to a luncheon meeting of the Spokane Chamber of Commerce held on Tuesday which was addressed by Everett S. Lee, president, AIEE, on the subject of, "What We Have Done Together." Although President Lee had had a background of the Pacific Northwest from personal experience early in his engineering career, he obtained from one of his electrical engineer friends the 1948 "Progress Edition of the Spokesman-Review," (parts 1 to 8 with parts 6 and 7 missing). He reviewed the growth of the inland empire industrial development, the practical potential of electric power in the area, references to the Columbia Basin, mining and agriculture, lumber and construction, as well as references to Richland, the atomic energy city, but nowhere did he find reference to the name of the Spokane Chamber of Commerce or the AIEE, nor of engineers at all except a brief reference to army engineers and a plant engineering group. President Lee knew from his own membership in the Schenectady Chamber of Commerce that this organization was at the back of all these achievements. He pointed out that in back of every project was the engineer. In back of all of the great dams and reclamation projects are the civil engineers; in the machinery, on the farms, in the factories, and in the mines, are the mechanical engineers; and in all of the metallurgy are the mining engineers, and in chemical process, the chemical engineers. He further cited that in all of the electric power and electric machinery everywhere; home and office, electric appliances, the telephone, telegraph, and radio, that everything we have comes from the electrical engineers and yet rarely is this mentioned.

In conclusion, he said that the electrical engineer was indebted to the businessmen of the Chambers of Commerce to progress the commerce and industry of the land, and in turn, the businessmen owed their all to the scientists and engineers who had made all of these achievements possible and particularly to the electrical engineer who has made them possible in the electrical field. He urged that each group recognize the other and the part played together in the accomplishments of the inland empire and in the whole country and say, "see, this we have done together."

Raymond P. Kelley, past president of the Spokane Chamber of Commerce, presided.

STUDENT ACTIVITIES

Student sessions were held on Wednesday evening and Thursday morning in which papers were presented by the students. President Lee talked to the students in the Thursday session and spoke from personal experiences. As a practical demonstration of professional recognition, he referred to a sensational play in a baseball game between Cincinnati and the Chicago Cubs during a during a meeting of the American Society for Engineering Education which was held in Cincinnati several years ago. Professional recognition was a part of the business under consideration at that meeting and President Lee found it difficult to interest his associates in the ball game, but he attended with two or three of them. During the game, with bases full, a fielder on the visiting team made a sensational catch. After a pause, the people in the Cincinnati stands all arose and applauded. That constitutes professional recognition. Next day after the story was heard, there was no difficulty in getting others to go to the ball game.

In conclusion, President Lee trusted that the counselors would have excellent co-operation during the year and that great good would come from having someone to come and talk to the students at their meetings. He suggested that the counselors refer their problems to H. N. Muller, chairman of the committee on Student Branches, who would be glad to be of assistance.

WEDNESDAY EVENING

With Norman Dam, Washington State College Student Branch chairman presiding, the following papers were presented:

"An Experimental and Mathematical Investigation of the Cycle Counter Discriminator," C. N. Winningstad, University of California (Branch prize paper)—presented by C. B. Ames, incoming Branch chairman

"Some Problems Involved in the Design of a Low-Range Ohmmeter," J. N. Harris, California Institute of Technology (prize Student paper, Los Angeles Section)—presented by Clem Savant, incoming Branch chairman

"Resonant-Circuit Switching of Shunt Capacitors," Melvin H. Judkis, Oregon State College—presented by Dick Swartz, incoming Branch chairman

"Magnetic Recorders," R. L. Bentley and J. R. Ehlert University of Utah—presented by Max D. Odekirk, incoming Branch secretary

"Drying Wood by Radiant Heat," James Barber, University of Idaho—presented by Jack Peterson, incoming Branch chairman

THURSDAY MORNING

Jack A. Peterson, University of Idaho, Student Branch chairman, presided at this session which included the following presentations:

Address by Everett S. Lee, president AIEE

"A Distributed Power Amplifier," A. P. Copson, Oregon State College

"An Electronic Pressure-Volume Indicator," William J. Schneider and R. C. Malneritch, University of Santa Clara—presentation by Carl A. Schneider

"A Simple Method for Measuring the Lonosphere," James Chester, University of Nevada

"A Critique of Engineering Education," Charles L. Golden, University of California

MEETING OF DISTRICT AND SECTION OFFICERS

Officers of Districts 8 (Pacific) and 9 (Northwest) and of the Sections in the two Districts held an informal meeting on Thursday morning, with President Lee and Secretary Henline present. Vice-President D. I. Cone of the Pacific District presided at the meeting.

President Lee spoke in enthusiastic terms regarding the splendid work being done by the Sections in the two Districts, and asked whether there were any problems that should be discussed. In response to a question, he explained that many members had been appointed to Institute committees upon Section recommendations. He also spoke briefly on the Institute's budget problems, his plans for the President's page in *ELECTRICAL ENGINEERING*, the plans for covering about half of the expenses of general and District meetings that are chargeable to the Institute treasury by the collection of member and nonmember registration fees, and means of building up interest and membership.

After referring to some of the efforts to establish an over-all engineering organization, he indicated that little progress is being made in that respect and that the individual members have the answer within themselves. He said the engineering profession is strong because it has strong societies which can operate jointly when that serves a useful purpose.

Vice-President Richard McKay of District 9 said President Lee is doing excellent work for the Institute in building up enthusiasm. Some of the Section officers participated in the discussion of certain of the topics mentioned above and others. The meeting afforded an ideal opportunity for closer acquaintanceship among the District and Section officers.

STUDENT LUNCHEON

Immediately following the Thursday morning session, a luncheon was held which was

attended by the counselors from Districts 8 and 9 for the Branch chairmen and students. Professor H. F. Lickey, chairman of the District committee on Student activities, District 9, presided, and asked each Branch counselor in turn to introduce representatives from his Branch.

Secretary Henline spoke briefly on the expansion of the Institute and some of the related problems. He looked forward to a 15 per cent increase in student enrollment over the number that were enrolled last year and he explained that an important purpose of Student activities was to bring the students in contact with members of the Institute. He explained that the number of technical committees had been increased to 31 organized into four broad groups and that expansion made it difficult to get a publication program. In conclusion, he outlined the publications of the Institute and explained that the preparation of the budget was a real problem to see what can be done within estimated income.

The second speaker, Vice-President D. I. Cone, reviewed activities at the summer general meeting held in Mexico and he highly recommended the papers which were presented at the education session. He referred to the many courtesies extended and the medals conferred on Past President Blake D. Hull and Secretary H. H. Henline at the special reception given to the board of directors by the councilmen of the City of Mexico, and the resolution of appreciation adopted by the directors. He believed that the holding of this type of meeting was a fine thing to do once in a while and the courtesies extended by the Mexican government officials were truly remarkable.

He advised that the award from the Member-for-Life fund to send the winners of the District Branch paper prize competitions in half the Districts each year to the summer general meeting to present their prize papers should be continued as long as there are funds available.

The prize awards that are available for the presentation of papers were outlined briefly by C. S. Rich, secretary of the committee on award of Institute prizes. Professor Lickey pertinently supplemented the remarks by calling attention that the rules governing the awards were published in *ELECTRICAL ENGINEERING* for December 1947, pages 1248–9.

The counselor of the University of California Branch commented briefly on the advantages of joint Branch operation.

JOINT LUNCHEON MEETINGS

Wednesday noon 200 attended a joint luncheon meeting with the Associated Engineers of Spokane. H. C. Glaze, chairman, introduced the honored guests and briefly gave the history of the association which was founded in 1911 as the Spokane Technical Society and in 1914 became known by its present name.

After the luncheon, an illustrated talk on "Applications of Induction and Dielectric Heating in Industry" was given by R. A. Nielsen of the Westinghouse Electric Corporation. As an introduction to the subject, Doctor Nielsen gave a clear concise illustration of induction heating and showed from the fundamental formula how the depth of penetration can be controlled by varying the frequency. One of the typical illustrations appropriate in the area of the Pacific Northwest was the shrinking of the edges of a band-saw so it can be run on crowned pulleys. When considering an induction heating installation, the speaker suggested that the following questions should be answered. "Is it economically sound to do it by induction heating?" "Will the better product that results, the use of less skilled labor, the faster production rate, the application of heat only where it is needed, and so forth, make this expensive form of heat the most economical one to use?"

The speaker explained that dielectric heating consists of using frequencies above two megacycles for heating materials ordinarily classed as electric insulators. Instead of winding a coil around the material to be heated, the material is placed between the plates of a capacitor, and the heating is done by the dielectric loss which is directly proportional to the higher frequencies producing more rapid heating. Each kind of material has a dielectric loss per cycle, damp materials heating more rapidly than dry ones. The difference in the heating rate between glue and wood is used to advantage in high-frequency edge-gluing presses where the glue is cured in a fraction of a minute.

SERVICE CLUBS LUNCHEONS

Most of the service clubs in Spokane regularly hold luncheon meetings in the various hotels on Thursday noon. These luncheons afforded an excellent opportunity for engineers to acquaint others with the significance of engineering achievements. President Lee spoke at the Kiwanis luncheon analyzing the significant points in the technical papers and interpreting them in terms understandable in public daily life. At another luncheon held by the Rotary Club, Doctor Charles F. Wagner, Manager of the central station engineering department, Westinghouse Electric Corporation, spoke on lightning, analyzing in simple terms the mechanism of lightning strokes, the ground wire or lightning arrester, and precautions to be taken in storms.

WOMEN'S ENTERTAINMENT

During the meeting the women were kept busy with a series of events arranged by Mrs. L. R. Gamble, Mrs. R. C. Kelly, and Mrs. H. L. Vincent. Tuesday noon luncheon groups were formed to become better acquainted followed by the president's reception and dance in the evening. Wednesday afternoon there was a tour of Spokane and a tea. Thursday a trip was taken up the Spokane Valley with luncheon at the Clark House on beautiful Hayden Lake, Idaho.

BANQUET AND PRESENTATION OF GOLF PRIZES

The banquet was held on Thursday evening in the Marie Antoinette Room at the

Allis-Chalmers photo

(Left) W. J. Rheingans, Allis-Chalmers; A. F. Darland, United States Bureau of Reclamation; and Lloyd Hunt, Southern California Edison Company, view a demonstration of actual cavitation during a Pacific general meeting conference conducted by Mr. Rheingans. (Right) A portion of the group attending the cavitation conference which was held at the Davenport Hotel in Spokane

Davenport Hotel, Vice-President Richard McKay presiding. President Lee spoke briefly of his personal experiences in Spokane and expressed appreciation for the friendships augmented way beyond expectations. He took occasion to introduce and thank personally each member of the general committee and the chairmen of the subcommittees for the splendid meeting.

Golf prizes were presented by W. L. Thrailkill, chairman of the golf committee, for the tournament played at the Spokane Country Club in the afternoon. Members of the Spokane Section rejoiced as it was announced that the John B. Fisken cup competition had been won by Richard C. Kelly so that the cup would reside in Spokane for the first time since donated by John B. Fisken who was a member of the Spokane Section. A bag boy was presented to a guest, R. J. Pangburn for the low net score. The runner up for low net score was Al O'Brion who received a sand iron. Other prizes consisting of one or two golf balls were won as follows:

Longest drive on number 1 fairway, Waldo Porter; shortest drive on number 1, J. G. Beard, Jr.; closest drive to hole on number 9, Glen George; closest second shot to hole on number 18, J. C. Hinkle; lowest gross score, Al O'Brion; birdies, Peter Diederick, J. A. Peterson, Mickey McCain, and R. C. Kelly; in the pond on number 4, R. L. Lemman; high gross score, J. H. Siegfried; high net score, J. H. Siegfried and E. E. Ralph; highest score easy par 3 hole, L. B. Robinson and E. E. Ralph; highest score on easy par 5, C. F. Terrell; 13 score on number 16, W. L. Thrailkill; consolation prizes, Gray Clifton, H. C. Glaze, and R. C. Kelly.

Entertainment during the banquet was provided by Tiny Talbot, master of ceremonies, in the form of jokes and magic. Myron Peters and Byron Swanson entertained with songs.

On behalf of the San Francisco Section, J. Robinson extended a warm cordial invitation to take a vacation trip to San Francisco next year, attend the Pacific general meeting, and enjoy the centennial.

Nucleonic Instruments Conference Held During Pacific Meeting

Four conference papers, two on instrumentation, one on high-voltage accelerators, and one on the design criteria for atomic power reactors were presented in the conference nucleonic instruments held on Tuesday, August 24, 1948, during the AIEE Pacific general meeting in Spokane, Wash.

The subject of "Health Physics and Related Instruments," was presented by G. H. Whipple, Jr., of the Hanford Works. He explained that health physics is concerned with the determination of the hazard from the deposition of radioisotopes in the body and from exposure of the whole body, or of limited parts of the body, to neutron, beta, and gamma radiation. It is now generally accepted that total irradiation of any part of the body from all sources, including radioactive contaminants deposited in the skin, should not exceed 300 mrem per week, that is, that total irradiation which produces the same biological effect as 0.3 roentgen per week of X or gamma radiation.

Health physics instruments must be reliable, sensitive, and easy to use. A feature of reliability which is peculiar to these instruments is the necessity of discriminating between different types of radiations. Many of the instruments must have a sensitivity of the order of 10^{-14} amperes. The art of health physics instrumentation is still in its infancy and it is only in the last year or two that there has been opportunity for scientists, engineers, and manufacturers to co-operate.

The instruments in common use were divided into six general categories as follows:

1. Personnel meters.
2. Alpha, beta, and gamma survey meters.
3. Neutron survey meters.
4. Hand and shoe counters.
5. Dust, gas, vapor, and water samplers.
6. Laboratory analytical counters.

A few examples of each were discussed and several of the instruments were displayed.

In conclusion, Mr. Whipple stated that the quantities of radioactive materials involved in the Hanford Works operation are enormous, yet there has not been a single radiation injury in the history of the plant. Credit for this record must be divided between the health physics instruments and the men who used them. The experience of the Hanford Works indicates that at least one of the problems of practical atomic energy is near a satisfactory solution.

The second conference paper, entitled "Survey of Nucleonic Instruments," was presented by N. A. Marshall of the Navy Radiological Defense Laboratory. The circuits for the major types of pulse counting instruments were explained and integrating types of instruments were outlined ranging in sizes from that of a fountain pen to instruments weighing about 11 pounds. In discussion, Doctor O. J. M. Smith, of California, explained that an X-ray detector is a fluorescent screen with a photomultiplier tube. Other uses of these instruments were mentioned such as the determination of X-ray exposure photo time, X-ray thickness gauges, the use of a Geiger counter for scanning large castings for flaws, use of the Geiger counter in X-ray diffraction work, and in connection with the photographic film badge. Still another use had to do with the operation of steel refining furnaces where a radioactive impurity of the same kind which can be detected or not detected is added to the charge as the type of material trying to be burned off.

In the third presentation, the various types of "High-Voltage Accelerators," were reviewed and classified by Jack T. Wilson, physicist for the Allis-Chalmers Manufacturing Company. The machines were classified in three main classes:

1. Accelerators employing no magnetic field.
2. Those employing a constant magnetic field.
3. Those employing a changing magnetic field.

Certain aspects of recent developments in the design of the second and third classes of these accelerators were discussed so that electrical engineers in general might have a better understanding of the equilibrium orbits and phase stability in these machines. In concluding, Mr. Wilson cited that the 22-million-volt betatron has been the first of the three types of machines to find important and practical use in industry. It has increased the thickness to at least 20 inches of a section of steel or bronze which may be inspected accurately with nondestructive X-ray analysis radiography. The energy range of typical X-ray machines was discussed and curves showed that the absorption curve for iron is nearly constant over the approximate range of from 3 to 22 million electron volts which is the region of most of the X rays produced by this type of betatron.

The fourth conference presentation, "Design Criteria for Atomic Power Reactors," was given by Bruce R. Prentice, nucleonics department of the General Electric Company The "high performance" power plant; the type for obtaining newly-created fissionable material from nonfissionable source material, uranium 238, or from thorium was considered. The process of producing more new fissionable material than is consumed although highly academic has become known as "breeding." In further discussion, the authors listed three major criteria which form the most important objectives effecting economy of a high performance nuclear reactor as:

1. A large margin of breeding new fissionable material per pound of material fissioned.

2. High turnover on the investment of fissionable material (high kilowatts per pound of invested fissionable material and short processing time).

3. Operation at maximum temperature.

Many other significant objectives which have yet to be solved such as to safeguard health from harmful radiations, automatic controls capable of meeting the acceleration and deceleration demands, simplified systems for handling of intensely radioactive fuel discharge, provision for continuous operation while changing and discharging the fuel, and provision for quick replacement or repair of radioactive parts, present important problems. In conclusion, Mr. Prentice made it clear that the achievement of a great many of these objectives in a degree sufficient to make atomic power competitive with other fuels involves the solution of a very great many difficult technical problems. He was not at all certain that these problems can all be solved in sufficient degree to make an economic and competitive atomic power industry based on synthetic fuels, a certainty.

Committee Issues Statement on Member-for-Life Fund Use

Acting upon a request by the AIEE board of directors the following statement on the use of the Members-for-Life Fund has been submitted by the Members-for-Life Fund committee.

Each year an increasing number of AIEE members arrive at the 35-year continuous membership status or at age 70, having paid dues for 30 years and in consequence become "Member for Life." A corollary privilege is the exemption from their annual dues payments. However, a fair proportion do not avail themselves of this privilege and, if circumstances permit, continue to pay dues. These are now accumulated in a restricted fund. The appropriations from this fund are directed toward objectives recommended by the Members-for-Life committee as approved by AIEE board of directors.

To date (August 1948) the fund principal remaining after current expenses is \$7,559.69 and it probably will grow at a rate of \$1,200 to \$1,500 per year.

The present use of the fund is to defray expenses of winners of District papers competitions, odd numbered and even numbered Districts alternating annually, to summer general meetings. The object is to promote interest and competition among younger AIEE members.

It is hoped that the fund will grow more rapidly so that it may increase in usefulness. Other objectives may be considered when the income is sufficient to defray costs.

AIEE Sections Officers 1948–49

Name	District	When Organized	Membership Aug. 1, 1948	Chairman	Secretary	Secretary's Address
Akron	2	Aug. 12, '20	109	C. R. Reid	N. A. Williams	Goodyear Tire & Rubber Co., Dept. 110-X, Akron, Ohio
Alabama	4	May 22, '29	158	H. J. Scholz	J. I. Greenhill	1316 46th St., West, Birmingham 8, Ala.
Arizona	8	Mar. 22, '41	112	C. M. Hart	Americo Lazzari	4323 North 14th Ave., Phoenix, Ariz.
Arkansas	7	Apr. 23, '47	77	H. W. Claybaugh	T. B. Lewis	6609 Kenwood Road, Little Rock, Ark.
Arrowhead	5	Apr. 23, '47	39	R. L. Boisen	J. F. Johnson	Minnesota Power & Light Co., Duluth, Minn.
Beaumont	7	June 27, '45	78	Avery L. Howell	R. W. Parker	Westinghouse Elec. Corp., 1213 American Nat'l Bank Bldg. Beaumont, Texas
Boston	1	Feb. 13, '03	803	F. B. Haeussler	L. F. Cleveland	Northeastern University, 360 Huntington Ave., Boston 15, Mass.
Canton	2	Nov. 5, '47	69	D. C. Krammes	W. D. Cropley	5436 Jonathan Ave., N. W., Canton 6, Ohio
Central Indiana	5	Jan. 12, '12	222	G. F. Switzer	G. M. Grabbe	4507 East 10th St., Indianapolis 1, Ind.
Chicago	5	1893	1487	F. D. Troxel	H. E. Nason	Westinghouse Elec. Corp., 20 North Wacker Drive, Chicago 6, Ill.
Cincinnati	2	June 30, '20	205	Ray E. Stroppel	John P. Quitter	509 Missouri Ave., Cincinnati 26, Ohio
Cleveland	2	Sept. 27, '07	629	J. D. Leitch	J. L. Fuller	Reliance Elec. & Engg. Co., 1088 Ivanhoe Road, Cleveland 10, Ohio
Columbus	2	Mar. 17, '22	131	Chester K. Bishop	Roger L. Merrill	691 North Dawson Ave., Columbus 3, Ohio
Connecticut	1	Apr. 16, '21	492	Clarence W. Mayott	Floyd W. Buck	United Illuminating Co., 80 Temple St., New Haven, Conn.
Dayton	2	June 9, '43	300	W. R. Appleman	C. H. Spitler	The Leland Elec. Co., P.O. Box 1060, Dayton 1, Ohio
Denver	6	May 18, '15	338	C. W. Keller	Evan R. Jones	Mountain States Tel. & Tel. Co., Box 960, Denver 1, Colo.
East Tennessee	4	Sept. 2, '36	342	R. W. McEver	Henry E. Williams	Knox Porcelain Corp., 100–200 Mynderse St., Knoxville 11, Tenn.
Erie	2	Jan. 11, '18	120	Charles L. Reed, Jr.	F. T. Parker	2304 Bird Drive, Erie, Pa.
Florida	4	Jan. 28, '31	225	R. S. Davis	Jess D. Thomas	904 Ethan Allen, Jacksonville, Florida
Fort Wayne	5	Aug. 14, '08	114	C. J. Herman	R. E. Trovinger	2703 Hoagland Ave., Fort Wayne 6, Ind.
Georgia	4	Jan. 14, '04	207	R. O. Loomis	James R. Raney	Georgia Power Co., 75 Marietta St., N. W., Atlanta, Ga.
Houston	7	Aug. 7, '28	246	H. C. Dillingham	E. G. Westheimer	Southwestern Bell Tel. Co., Box 1780, Houston 2, Texas
Illinois Valley	5	June 30, '45	117	Walter J. Johnson	George E. Walters	707 East Lawndale Ave., Peoria 4, Ill.
Iowa	5	June 29, '29	159	John V. Gebuhr	John H. O'Day	Northwestern Bell Tel. Co., Des Moines, Iowa
Ithaca	1	Oct. 15, '02	158	P. D. Ankrum	E. M. Guyer	Corning Glass Works, Corning, N. Y.
Kansas City	7	Apr. 14, '16	228	J. E. Murray	Ivan T. Knight	Kansas City Power & Light Co., 1330 Baltimore Ave., Kansas City 10, Mo.
Lehigh Valley	2	Apr. 16, '21	281	J. E. Treweek	A. L. Price	173 South Church St., Hazleton, Pa.
Los Angeles	8	May 19, '08	1179	Bradley Cozzens	J. H. Vivian	301 No. Gerona Ave., San Gabriel, Calif.
Louisville	4	Oct. 15, '26	110	M. G. Northrop	R. D. Spalding	2595 Greenup, Louisville 4, Ky.
Lynn	1	Aug. 22, '11	228	R. G. Slauer	R. E. Franck	General Elec. Co., 40 Federal St., West Lynn, Mass.
Madison	5	Jan. 8, '09	82	Lawrence F. Kehoe	Leonard Hesse	2075 Winnebago St., Madison 4, Wis.
Mansfield	2	Mar. 6, '39	68	C. W. Freeman	H. R. Delahooke	North Elec. Mfg. Co., Galion, Ohio
Maryland	2	Dec. 16, '04	536	Robert L. McCoy	John W. Gore	3707 Woodbine Ave., Baltimore 7, Md.
Memphis	4	May 22, '30	106	James R. Morton	Wm. B. Thompson	Firestone Tire & Rubber Co., Firestone Bldg., Memphis 7, Tenn.
Mexico	7	June 29, '22	202	Manuel M. De Lascurain	George B. Doughman	Apartado 403, Mexico D.F., Mexico
Michigan	5	Jan. 13, '11	695	M. R. Horne	E. Dissmeyer	Consumers Power Bldg., Jackson, Mich.
Milwaukee	5	Feb. 11, '10	621	E. T. Sherwood	E. J. Limpel	A. O. Smith Corp., Milwaukee, 1, Wis.
Minnesota	5	Apr. 7, '02	240	Harry P. Bruncke	Albert J. Hendry	3211 24th Ave. South, Minneapolis 6, Minn.
Montana	9	June 24, '31	84	Sidney McArthur	Dennis A. Johnson	1406 2nd Ave. N., Great Falls, Mont.
Montreal	10	Apr. 16, '43	308	M. C. Thurling	A. Malkin	Canadian Car & Foundry Co. Ltd., 621 Craig St., West, Montreal P.Q.3, Canada
Muscle Shoals	4	Feb. 18, '38	23		Evan V. Raffalovich	208 Circular Drive, Florence, Ala.
Nebraska	6	Jan. 21, '25	85	A. A. Little	Claude N. Allen	Allis-Chalmers Mfg. Co., 9th & Farnam Sts., Omaha 8, Nebr.
New Mexico–West Texas	7	Mar. 7, '40	108	O. F. Metz	Lee R. Hammond, Jr.	2910 Grant Ave., El Paso, Texas
New Orleans	4	Dec. 8, '33	210	M. G. Zervigon	E. I. Blanchard	Louisiana Power & Light Co., 433 Metairie Road, New Orleans, 20, La.
New York	3	Dec. 10, '19	4715	R. T. Oldfield	J. D. Tebo	Bell Telephone Labs., Inc., 463 West St., New York 14, N. Y.
Niagara Falls		Aug. 5, '48	79	W. Lore Eliason	John A. Persson	P.O. Box 580, Union Carbide & Carbon Research Lab., Inc., Niagara Falls, N. Y.
Niagara Frontier	1	Feb. 10, '25	249	John E. Sowers	Berton S. Rice	Buffalo Niagara Elec. Corp., Electric Bldg., Buffalo 3, N. Y.
North Carolina	4	Mar. 21, '29	206	C. G. Brennecke	W. D. Stevenson	North Carolina State College of Agri. & Engg., Raleigh, N. C.
North Texas	7	May 18, '28	307	J. M. Hagler	P. G. Wallace	Texas Power & Light Co., P.O. Box 6331, Dallas 2, Texas
Oklahoma City	7	Feb. 16, '22	168	Paul Berry	Harold L. Pickens	Allis-Chalmers Mfg. Co., 901 West Grand, Oklahoma City 4, Okla.
Panhandle Plains	7	June 12, '47	89	R. F. McClure	R. P. Miller	City of Lubbock, Lubbock, Texas
Philadelphia	2	Feb. 18, '03	1248	A. P. Godsho	H. H. Sheppard	Rumsey Elec. Co., 1007 Arch St., Philadelphia 7, Pa.
Pittsburgh	2	Oct. 13, '02	916	H. H. Wagner	F. H. Schlough	416 7th Ave., Pittsburgh, Pa.
Pittsfield	1	Mar. 25, '04	240	Horace S. Hubbard	J. H. Hagenguth	General Elec. Co., 100 Woodlawn Ave., Pittsfield, Mass.
Portland	9	May 18, '09	407	M. M. Ewell	Howard Arnett	Portland General Elec. Co., 621 S.W. Alder St., Portland 5, Oreg.
Providence	1	Mar. 12, '20	129	William B. Carnie	Chester B. Leathers	General Elec. Co., 111 Westminster St., Providence, R. I.
Richland	9	Apr. 23, '48	61	H. R. Hughes	J. H. Hemperly	General Elec. Co., Project Engg. Div., Richland, Wash.
Rochester	1	Oct. 9, '14	204	C. G. Plomasen	John H. Rogers	Eastman Kodak Co., Camera Works, Rochester 4, N. Y.
Rock River Valley	5	Apr. 23, '47	69	Warner A. Johnson	Sheldon A. Coxhead	Central Illinois Elec. & Gas Co., 305 N. Main St., Rockford, Ill.
St. Louis	7	Jan. 14, '03	446	R. W. Gaskins	E. E. Gilcrease	4930 San Francisco Ave., St. Louis 15, Mo.
San Diego	8	Jan. 18, '39	150	H. A. Cordes	J. P. Conner	5040 Westminster Terrace, San Diego 4, Calif.
San Francisco	8	Dec. 23, '04	1137	O. A. Gustafson	W. L. Carter	Pacific Tel. & Tel. Co., 140 New Montgomery St., San Francisco 5, Calif.
Schenectady	1	Jan. 26, '03	839	H. L. Palmer	L. T. Rader	General Elec. Co., Control Engg. Div., Schenectady 5, N. Y.
Seattle	9	Jan. 19, '04	374	Harold R. Brown	F. R. Bergseth	Dept. of Elec. Engg., University of Washington, Seattle 5, Wash.
Sharon	2	Dec. 11, '25	158	E. W. Tipton	G. R. Monroe	1108 Memorial Blvd., Sharon, Pa.
Shreveport	4	June 12, '47	65	R. O. Williams	L. T. Williams	P.O. Box 1106, Shreveport, La.
South Bend	5	Feb. 26, '41	95	R. M. Koontz	C. O. Moyer	1134 Lincolnway, West., South Bend, Ind.
South Carolina	4	Mar. 2, '40	86	Max G. Toole	E. Parker Miller	South Carolina Elec. & Gas Co., P.O. Box 390, Columbia, S. C.
South Texas	7	May 23, '30	131	M. F. Noster	A. C. Alberti	City Public Service Board, 201 No. St. Mary's St., San Antonio 6, Texas
Spokane	9	Feb. 14, '13	125	O. W. Hurd	S. J. Pope	952 East 40th Ave., Spokane 10, Wash.
Springfield	1	June 29, '22	93	J. L. Hyland	D. W. Hoot	2708 Main St., Springfield 7, Mass.
Syracuse	1	Aug. 12, '20	203	L. M. Moore	J. D. Hershey	General Electric Co., 113 S. Salina St., Syracuse 2, N. Y.
Toledo	2	June 3, '07	103	M. W. Keck	Walter M. Campbell	2145 Central Grove Ave., Toledo, Ohio
Toronto	10	Sept. 30, '03	509	J. F. Moore	W. R. Harmer	Hydro Elec. Power Comm. of Ontario, 620 University Ave., Toronto, Ont.
Tulsa	7	Oct. 1, '37	101	Sim C. Wright	G. R. Van Burkler	Public Service Co., 600 S. Main, Tulsa 1, Okla.
Urbana	5	Nov. 25, '02	88	A. D. Bailey	D. F. Hang	Dept. of Elec. Engg., University of Illinois, Urbana, Ill.
Utah	9	Mar. 9, '17	110	Thomas Jordan	John A. McDonald	General Elec. Co., P.O. Box 779, Salt Lake City, 1, Utah.
Vancouver	10	Aug. 22, '11	167	J. H. Steede	D. S. Smith	4093 13th Ave. West, Vancouver B. C., Canada
Virginia	4	May 19, '22	210	Wm. T. Johns	P. R. Spracher	P.O. Box 1194, Richmond 19, Va.

Sections *(Continued)*

Washington	2	Apr. 9, '03	790	R. D. Bennett	W. J. Lank	Potomac Elec. Power Co., 10th & E Sts. N.W., Washington 4, D. C.
West Virginia	2	Apr. 9, '40	102	T. R. Cooper	James L. Simpson	10 Brookland Court, Charleston 1, W. Va.
Wichita	7	Sept. 16, '37	86	E. D. Manspeaker	J. E. McNicol	Kansas Gas & Elec. Co., 201 No. Market, Wichita 2, Kansas
Worcester	1	Feb. 18, '20	81	Douglas L. Watkins	Wilfred G. Coleman	General Elec. Co., 507 Main St., Worcester 8, Mass.
Total Section	83		27,667			

Subsections

Name	Chairman	Secretary	Secretary's Address
Albuquerque (New Mexico–West Texas Section)	Walter F. Hardgrave		
Baton Rouge (New Orleans Section)	A. K. Ramsey, Jr.	F. R. Adams	Southern Bell Tel. & Tel. Co., 555 Florida St., Baton Rouge 8, La.
Binghamton Area (Ithaca Section)	J. R. Stover	W. J. Rider	P.O. Box 1081, Binghamton, N. Y.
Boulder City (Los Angeles Section)	Albert E. Hamilton	William M. Doak	P.O. Box 398, Henderson, Nevada
Casper, Wyo. (Denver Section)	B. A. Fleshman	C. R. McLean	Mountain States Power Co., Casper, Wyo.
Centre County (Pittsburgh Section)	R. E. Armington	W. B. Sheppard	Elec. Engg. Dept., Pennsylvania State College, State College, Pa.
Charleston (South Carolina Section)	David T. Coleman	C. Y. House, Jr.	P.O. Box 303, Charleston, S. C.
Charlotte (North Carolina Section)	Russell Ranson	J. S. Myers	P.O. Box 1969, Charlotte, N. C.
Corpus Christi (South Texas Section)	George A. Mills	Thomas E. Duce	P.O. Box 1819, Corpus Christi, Texas
Fort Worth (North Texas Section)	F. E. Woodruff	C. K. Beyette	2304 Loraine Court, Fort Worth 3, Texas
Fox River Valley (Milwaukee Section)	Jesse W. Pomazal	Joseph J. Rock	Giddings & Lewis, Fond du Lac, Wis.
Freeport (Houston Section)	B. J. Nankervis	H. K. Brown	1414 West 5th St., Freeport, Texas
Fresno (San Francisco Section)	F. E. Miller	Clyde L. Smith	Pacific Gas & Electric Co., 1401 Fulton St., Fresno 24, Calif.
Great Falls (Montana Section)	Sidney E. McArthur	D. C. Thurber	725 Fairhaven, Great Falls, Mont.
Hamilton (Toronto Section)	C. E. Moorhouse	T. H. Lewis	Hydro Electric Power Comm. of Ontario, Box 434, Hamilton, Ont., Canada
Hampton Roads (Virginia Section)	L. Saunders	K. O. Joyner	45 Algonquin, Hampton, Va.
Hudson Valley (New York Section)	M. S. Kozik	E. W. Paquin	Central Hudson Gas & Elec. Corp., South Road, Poughkeepsie, N. Y.
Jackson (Miss) (New Orleans Section)	Joseph B. Fountain	A. N. Saxon	Graybar Elec. Co., 758 Ricks St., Jackson, Miss.
Jacksonville (Florida Section)	R. M. Garth		
Johnstown (Pittsburgh Section)			
Lake Charles (New Orleans)	J. W. Kirkland	W. W. Crossley	1317 Shaw St., Lake Charles, La.
Lancaster–York (Maryland Section)	J. L. Stauffer	W. H. Freund	RCA Mfg. Co., Lancaster, Pa.
Miami (Florida Section)	Harvey F. Pierce	C. V. Booth	% Maurice H. Connell & Associates, Langford Bldg., Miami 32, Fla.
New Jersey (New York Section)	Lawrence J. Lunas	J. L. Blackburn	Westinghouse Electric Corp., Newark 1, N. J.
Oak Ridge (East Tennessee Section)	A. D. Taylor		
Ottawa (Montreal Section)	G. R. Davis	R. M. Morris	National Research Council, Sussex St., Room 70, Ottawa, Ont., Canada
Quad Cities (Iowa Section)	Raymond C. Judd	E. H. Breckenfelder	P.O. Box 537, Muscatine, Iowa
Red River Valley (Minnesota Section)	Thomas C. Wright	James A. Tyvand	Otter Tail Power Co., Fergus Falls, Minn.
Richmond (Virginia)	Bruce C. Halsted	C. E. McMurdo	3523 Patrick Ave., Richmond 22, Va.
Sacramento (San Francisco Section)	E. S. Prud'Homme	Chas. R. Day	Sacramento Municipal Utility Dist., P.O. Box 2391, Sacramento, Calif.
St. Maurice Valley (Montreal Section)	M. Eaton	Donald King	P.O. Box 70, Shawinigan Falls, Que., Canada
Saginaw Valley (Michigan Section)	H. R. Walker	E. L. Holmgren	400 Park Ave., Bay City, Mich.
San Jose (San Francisco Section)	J. Scott Kay	L. O. Templeton	Westinghouse Electric Corp., Project 28, Sunnyvale, Calif.
Shasta (San Francisco Section)	M. E. Guile	W. G. Whitney	Pacific Gas & Electric Co., 301 Main St., Chico, Calif.
Tampa (Florida Section)	R. S. Davis		
West Central Texas (North Texas Section)	Dan W. Whitaker	E. N. Mitchell	General Meter Dept., West Texas Utilities Co., Abilene, Texas
Western Virginia (Virginia Section)	G. L. Seay	J. B. Whitmore	P.O. Box 2021, Roanoke, Va.
Wilmington (Philadelphia Section)	Henry Evans	William J. Mearns	Hercules Powder Co., 900 Market St., Wilmington 99, Del.
Zanesville (Columbus Section)	R. P. Thompson	R. W. Hartsook	1637 Norwood Blvd., Zanesville, Ohio

Geographical District Executive Committees

District	Chairman (Vice-President, AIEE)	Secretary (District Secretary)	Chairman, District Committee on Student Activities
1 North Eastern	Victor Siegfried, American Steel & Wire Co., Worcester 7, Mass.	Frederick G. Webber, 9 Federal Court, Springfield 5, Mass.	E. R. McKee, University of Vermont, Burlington, Vt.
2 Middle Eastern	G. W. Bower, 127 Hopkins Ave., Haddonfield, N. J.	A. C. Muir, Berwind-White Coal Mining Co., 1138 Commercial Trust Bldg., Philadelphia 2, Pa.	J. L. Beaver, Lehigh University, Bethlehem, Pa.
3 New York City	J. L. Callahan, R. C. A. Laboratories, Radio Corporation of America, 66 Broad St., New York 4, N. Y.	W. J. Barrett, New Jersey Bell Tel. Co., 540 Broad St., Newark 1, N. J.	F. A. Wahlers, Polytechnic Inst. of Brooklyn, 99 Livingston St., Brooklyn 2, N. Y.
4 Southern	J. H. Berry, Electric Dept., Virginia Electric and Power Co., Norfolk 1, Va.	T. H. Mawson, Commonwealth & Southern Corp., 600 N. 18th St., Birmingham 2, Ala.	W. O. Leffell, University of Tennessee, Knoxville, Tenn.
5 Great Lakes	Ira A. Terry, General Electric Co., Fort Wayne 2, Ind.	N. C. Pearcy, Pioneer Service & Engineering Co., 231 South La Salle St., Chicago 4, Ill.	W. H. Gamble, South Dakota State College, Brookings, S. D.
6 North Central	I. M. Ellestad, Northwestern Bell Telephone Co., 823 Telephone Bldg., Omaha 2, Nebr.	M. L. Burgess, Westinghouse Electric Corp., 117 N. 13th St., Omaha 2, Nebr.	J. O. Kammerman, South Dakota School of Mines & Technology, Rapid City, S. Dak.
7 South West	G. N. Pingree, General Electric Co., 1801 North Lamar St., Dallas 2, Texas	Gibbs A. Dyer, Southwestern Bell Tel. Co., Dallas, Texas	F. W. Tatum, Southern Methodist University, Dallas, Texas
8 Pacific	D. I. Cone, Pacific Tel. & Tel. Co., 140 New Montgomery St., San Francisco 5, Calif.	B. D. Dexter, 245 Market St., San Francisco, Calif.	W. G. Hoover, Stanford University, Stanford University, Calif.
9 North West	Richard McKay, Washington Water Power Co., West 825 Trent Ave., Spokane 6, Wash.	H. C. Glaze, Jr., General Electric Co., S. 162 Post St., Spokane 8, Wash.	H. F. Lickey, Washington State College, Pullman, Wash.
10 Canada	D. G. Geiger, Bell Telephone Co. of Canada Ltd., 76 Adelaide St.W., Toronto 1, Ont.	J. Taylor Fisher, 76 Adelaide St. West, Toronto 1, Ont.	W. B. Coulthard, University of British Columbia, Vancouver, B. C.

NOTE: Each District executive committee includes also the chairmen and secretaries of all Sections within the District, the District vice-chairman of the AIEE membership committee, and a member of the Sections Committee resident in the District.

AIEE Student Branches 1948–49

Name and Location	District	Counselor (Member of Faculty)
Akron, University of, Akron, Ohio	2	
Alabama Polytechnic Inst., Auburn	4	R. D. Spann
Alabama, University of, University	4	W. F. Gray
Alberta, University of, Edmonton, Canada	10	R. E. Phillips
Arizona, University of, Tucson	8	J. C. Clark
Arkansas, Univ. of, Fayetteville	7	W. B. Stelzner
British Columbia, Univ. of, Vancouver, Canada	10	W. B. Coulthard
Brooklyn Polytechnic Inst. of, Brooklyn, N. Y. (Day)	3	F. A. Wahlers
Brooklyn Polytechnic Inst. of, Brooklyn, N. Y. (Evening)	3	Anthony B. Giordano
Brown University, Providence, R. I.	1	Leon C. Leoni
Bucknell University, Lewisburg, Pa.	2	Richard G. Plaisted
California Inst. of Technology, Pasadena	8	William H. Pickering
California, University of, Berkeley	8	R. M. Saunders
Carnegie Inst. of Technology, Pittsburgh, Pa.	2	E. M. Williams
Case Inst. of Technology, Cleveland, Ohio	2	Carl F. Schuneman
Catholic Univ. of America, Washington, D. C.	2	
Cincinnati, Univ. of, Cincinnati, Ohio	2	A. C. Herweh
Clarkson College of Technology, Potsdam, N. Y.	1	Alfred R. Powers
Clemson A. & M. College, Clemson, S. C.	4	F. T. Tingley
Colorado A. & M. College, Fort Collins	6	C. H. Chinburg
Colorado, University of, Boulder, Colo.	6	Platt Wicks
Columbia University, New York, N. Y.	3	W. A. LaPierre
Connecticut, Univ. of, Storrs	1	L. E. Williams
Cooper Union, New York, N. Y.	3	E. W. Starr
Cornell University, Ithaca, N. Y.	1	M. S. McIllroy
Delaware, University of, Newark	2	
Denver, University of, Denver, Colo.	6	A. M. Stiles
Detroit, University of	5	H. O. Warner
Drexel Inst. of Technology, Philadelphia, Pa.	2	F. C. Powell
Duke University, Durham, N. C.	4	Otto Meier, Jr.
Florida, University of, Gainesville	4	F. H. Pumphrey
George Washington Univ., Washington, D. C.	2	
Georgia Inst. of Technology, Atlanta, Ga.	4	H. B. Duling
Harvard University, Cambridge, Mass.	1	John C. Fisher
Idaho, University of, Moscow	9	J. Hugo Johnson
Illinois Inst. of Technology, Chicago	5	E. T. B. Gross
Illinois, University of, Urbana	5	E. A. Reid
Iowa State College, Ames	5	G. Richardson
Iowa, University of, Iowa City	5	E. B. Kurtz
Johns Hopkins University, Baltimore, Md.	2	T. Benjamin Jones
Kansas State College, Manhattan	7	Joe E. Ward
Kansas, University of, Lawrence	7	David D. Robb
Kentucky, University of	4	Brinkley Barnett
Lafayette College, Easton, Pa.	2	
Lehigh University, Bethlehem, Pa.	2	J. L. Beaver
Louisiana State University, Baton Rouge	4	W. D. Morris
Louisville, University of, Louisville, Ky.	4	T. R. Bailey
Maine, University of, Orono	1	P. M. Seal
Manhattan College, New York, N. Y.	3	Robert T. Weil
Marquette University, Milwaukee, Wis.	5	E. W. Kane
Maryland, University of, College Park	2	L. J. Hodgins
Massachusetts Inst. of Technology, Cambridge	1	E. W. Boehne
Michigan College of Mining & Technology, Houghton	5	G. W. Swenson
Michigan State College, East Lansing	5	C. E. Goodell
Michigan, University of, Ann Arbor	5	J. S. Gault
Milwaukee School of Engineering, Milwaukee, Wis.	5	R. J. Ungrodt
Minnesota, University of, Minneapolis	5	J. H. Kuhlmann
Mississippi State College	4	Harry C. Simrall
Missouri School of Mines & Metallurgy, Rolla	7	I. H. Lovett
Missouri, University of, Columbia	7	J. F. Lamb
Montana State College, Bozeman	9	E. W. Schilling
Nebraska, University of, Lincoln	6	C. W. Rook
Nevada, University of, Reno	8	I. J. Sandorf
Newark College of Engineering, Newark, N. J.	3	C. R. Moore
New Hampshire, University of, Durham, N. H.	1	R. E. Anderson
New Mexico College of A. & M. Arts, State College	7	Russell L. Reise
New Mexico, University of, Abuquerque	7	Ralph W. Tapy
New York, College of the City of, New York, N. Y.	3	Harry Baum
New York University, New York	3	S. G. Lutz
North Carolina State College, Raleigh	4	W. D. Stevenson, Jr.
North Dakota State Agri. College, Fargo	5	Harry S. Dixon
North Dakota, University of, Grand Forks	5	K. B. MacKichan
Northeastern University, Boston, Mass.	1	Roland G. Porter
Northwestern University, Evanston, Ill.	5	A. H. Wing
Norwich University, Northfield, Vt.	1	F. A. Spencer
Notre Dame, University of, Notre Dame, Ind.	5	L. F. Stauder
Ohio Northern University, Ada	2	
Ohio State University, Columbus	2	Edmund D. Ayres
Ohio University, Athens	2	D. B. Green
Oklahoma A. & M. College, Stillwater	7	Charles F. Cameron
Oklahoma, University of, Norman	7	Gerald Tuma
Oregon State College, Corvallis	9	Melvin J. Kofoid
Pennsylvania State College, State College	2	A. P. Powell
Pennsylvania, University of, Philadelphia	2	Kenneth Fegley
Pittsburgh, University of, Pittsburgh, Pa.	2	R. C. Gorham
Pratt Institute, Brooklyn, N. Y.	3	Donald H. Wright
Princeton University, Princeton, N. J.	2	
Puerto Rico, University of, Mayaguez, P. R.	3	Miguel Wiewall, Jr.
Purdue University, Lafayette, Ind.	5	C. R. Nichols
Rensselaer Polytechnic Institute, Troy, N. Y.	1	Emerson D. Broadwell
Rhode Island State College, Kingston	1	Wm. C. Birtwell
Rice Institute, Houston, Tex.	7	J. S. Waters
Rose Polytechnic Institute, Terre Haute, Ind.	5	C. C. Knipmeyer
Rutgers University	3	P. S. Creager
Santa Clara, Univ. of, Santa Clara, Calif.	8	Henry P. Nettesheim
South Carolina, Univ. of, Columbia	4	S. A. Ferguson
South Dakota State College, Brookings	5	Wm. H. Gamble
South Dakota School of Mines & Tech. Rapid City	6	J. O. Kammerman
Southern California, Univ. of, Los Angeles	8	Rodney C. Lewis
Southern Methodist Univ., Dallas, Tex.	7	F. W. Tatum
Stanford University, Stanford University, Calif.	8	Wm. G. Hoover
Stevens Inst. of Technology, Hoboken, N. J.	3	W. L. Sullivan
Swarthmore College, Swarthmore, Pa.	2	C. A. Lister
Syracuse University, Syracuse, N. Y.	1	Edward Shelton
Tennessee, University, Knoxville	4	W. O. Leffell
Texas, A. &. M. College of, College Station	7	N. F. Rode
Texas Technological College, Lubbock	7	
Texas, University of, Austin	7	A. J. McCrocklin, Jr.
Toronto, University of	10	L. S. Lauchland
Tufts College, Medford, Mass.	1	A. H. Howell
Tulane University, New Orleans, La.	4	Albert C. Buxton
Union College, Schenectady, N. Y.	1	Owen G. Owens
Utah, University of, Salt Lake City	9	O. C. Haycock
Vanderbilt University, Nashville, Tenn.	4	S. R. Schealer
Vermont, University of, Burlington	1	John E. Dean
Villanova College, Villanova, Pa.	9	
Virginia Military Institute, Lexington	4	
Virginia Polytechnic Institute, Blacksburg	4	Claudius Lee
Virginia, University of, Charlottesville	4	L. R. Quarles
Washington, State College of, Pullman	9	O. E. Osburn
Washington, University of, Seattle	9	Vinson L. Palmer
Washington University, St. Louis, Mo.	7	Pierre M. Honnell
Wayne University, Detroit, Michigan	5	W. H. Bixby
West Virginia University, Morgantown	2	Everette C. Dubbe
Wisconsin, University of, Madison	5	John C. Weber
Worcester Poly. Institute, Worcester, Mass.	1	Donald C. Alexander
Wyoming, University of, Laramie	6	R. O. Trueblood
Yale University, New Haven, Conn.	1	A. G. Conrad

Total Branches........127

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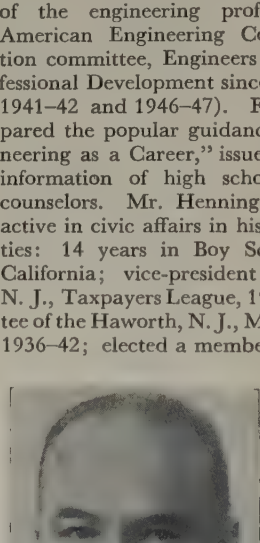
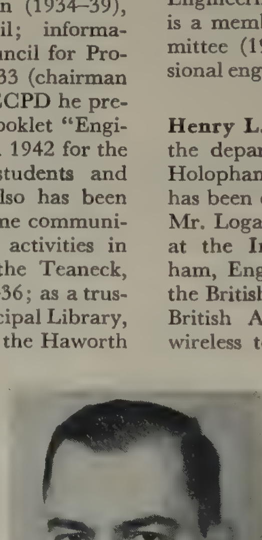
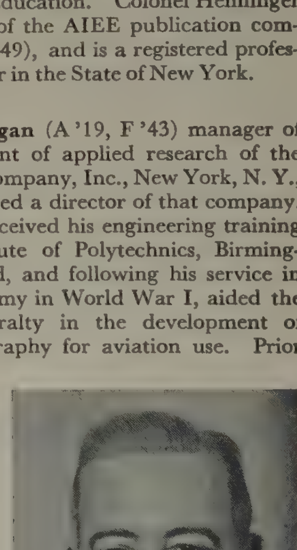
PERSONAL NOTES.......

G. Ross Henninger (A '22, M '27, F '43) a member of the AIEE headquarters staff since 1930, and editor of *ELECTRICAL ENGINEERING* since January 1, 1933, has resigned to become editor and general manager of publications for the Illuminating Engineering Society, New York, N. Y. He was born in Hamilton, Ohio, May 22, 1898; attended the public schools of Ocean Park, Venice, and Santa Monica, Calif.; received the degree of bachelor of science in electrical engineering from the University of Southern California, Los Angeles, with the class of 1922, after completion of extracurricular work in the fields of civil engineering and business administration. During his university career he served the university as laboratory instructor in physics and electrical engineering, and also was a full-time employee of the Southern California Edison Company, Ltd., serving in the company's operating department as a substation and powerhouse night-shift operator. Upon graduation, he entered the student course of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., subsequently becoming a member of the relay section of the company's supply engineering department where he spent a year in laboratory, office, and field work. Leaving the employ of the Westinghouse company, Mr. Henninger re-entered the services of the Edison company in 1923 as operating assistant to the electrical protection engineer, in which position he was charged with responsibility for the satisfactory operation of the protective relay equipment throughout the company's system. In 1924, he left the Edison company and moved to San Francisco to become engineering editor of the then *Journal of Electricity* (which subsequently changed its name to *Electrical West*), the Pacific Coast publication of the McGraw-Hill Publishing Company, Inc. In that position he developed and was in responsible charge of the technical department of the magazine until he went to New York in 1930 as associate editor for the AIEE. He remained in the latter position until he was named editor in 1933. Mr. Henninger had been active in Institute affairs for many years prior to his employment on headquarters staff. He was one of the organizers and was first chairman (1921) of the Student Branch at the University of Southern California, and served on various Pacific Coast convention committees (1925–30). When he left the Pacific Coast in 1930, he was vice-chairman of the San Francisco Section, and chairman of the San Francisco Engineers' Club entertainment committee. During his employment by the Institute, he has served in various capacities in activities carried on jointly by AIEE and other societies, including: publicity and publication committee (1933–40) and committee on economic status of the engineering profession (1934–39), American Engineering Council; information committee, Engineers Council for Professional Development since 1933 (chairman 1941–42 and 1946–47). For ECPD he prepared the popular guidance booklet "Engineering as a Career," issued in 1942 for the information of high school students and counselors. Mr. Henninger also has been active in civic affairs in his home communities: 14 years in Boy Scout activities in California; vice-president of the Teaneck, N. J., Taxpayers League, 1934–36; as a trustee of the Haworth, N. J., Municipal Library, 1936–42; elected a member of the Haworth Board of Education, 1940–2 (president 1942); and presently serving an elected term on the Borough Council. From 1942 through 1945 he was on active duty as a lieutenant-colonel in the Army Air Forces, having been granted leave of absence from the staff of *ELECTRICAL ENGINEERING*. Prior to entering active military service in 1942, Mr. Henninger had devoted a substantial amount of his time for several months to the United States Navy Department in Washington in the organization of an editorial and review section in the office of the Secretary of the Navy for the co-ordination of Navy publications. He was appointed a lieutenant-colonel in the Army Specialists Corps in 1942 to serve as a liaison officer on the staff of the Director General of the corps at Washington, D. C., assisting the Signal Corps and the Air Corps in the procurement of technical personnel. In the latter part of that year he was commissioned a lieutenant-colonel in the Army of the United States and transferred to the Army Air Forces with the immediate assignment to the then newly established Air Service Command headquarters at Patterson Field, Dayton, Ohio. In October 1944 he became chief of the Maintenance Data Section and a member of the staff of the chief of the Maintenance Division of what by that time had become the headquarters, Air Technical Service Command, through consolidation of the original Air Service and Materiel Commands. His expanded duties included direct responsibility for procurement, preparation, publication, and dissemination of the technical and instructional literature required for the operation, maintenance, and repair of all equipment used by the Army Air Forces. While on terminal leave he was promoted to full colonel, which rank he now holds in the active reserve of the United States Air Force. In 1946 he was elected a director of the New York County chapter of the National Society of Professional Engineers for the 1946–48 term. He also is a member of the American Society for Engineering Education. Colonel Henninger is a member of the AIEE publication committee (1948–49), and is a registered professional engineer in the State of New York.

Henry L. Logan (A '19, F '43) manager of the department of applied research of the Holophane Company, Inc., New York, N. Y., has been elected a director of that company. Mr. Logan received his engineering training at the Institute of Polytechnics, Birmingham, England, and following his service in the British Army in World War I, aided the British Admiralty in the development of wireless telegraphy for aviation use. Prior


G. R. Henninger


A. C. Monteith


H. L. Logan

to joining the Holophane Company in 1919 as a consultant in illumination engineering, Mr. Logan was technical director of the L. Sonneborn Sons, Inc., of New York, N. Y. During the last 29 years with the Holophane Company, he was instrumental in the adoption of high-intensity production lighting for the automotive and tire industries, and in the development of the multi-controlens system for surgical work now in use in hospitals throughout the world. Mr. Logan was a pioneer in "built-in" lighting and illuminating systems developed by him were used extensively at both the Chicago Century of Progress (1933) and the New York World's Fair (1939), as well as in numerous theatres, hospitals, and public buildings. Among his major inventions are the "Filterlite," the Chromograph, the "Modelite" display system, and lighting devices for use in the fields of television, radio, dental surgery, optics, and architecture. Mr. Logan is the author of many articles and lectures on illumination and holds a fellowship in the Illuminating Engineers Society. In 1922 and 1923, Mr. Logan served on the AIEE lighting and illumination committee.

Abe M. Zarem (A '43) former chief of the electrical section of the physical research division at the United States Naval Ordnance Test Station, Pasedena, Calif., has been appointed chairman of physics research and manager of the new Los Angeles Division of the Stanford Research Institute, Calif. Doctor Zarem, an authority on ultrahigh-speed photography and measurement techniques and inventor of the Zarem camera, is a graduate of the Armour Institute of Technology and was, during the war, a research engineer and group leader on several secret government contracts in electronics and physics. In this new position as manager of the Los Angeles Division, Doctor Zarem will co-ordinate the technical and administrative activities of his organization with those of the main office of the Stanford Research Institute at Stanford University. Among his professional affiliations, he includes membership in the American Institute of Physics, the American Institute of Radio Engineers, and Eta Kappa Nu, Sigma Xi, and Tau Beta Pi fraternities.

Alexander C. Monteith (A '25, F '45) engineering executive of the Westinghouse Electric Corporation, East Pittsburgh, Pa., has been named vice-president in charge of engineering and research of that company. Mr. Monteith was born in Brucefield, Ontario, Canada, on April 10, 1902, and recevied his degree in electrical engineering from the Queens University, Kingston, Ontario, Canada, in 1923. He entered the graduate student course of the Westinghouse Corporation at the East Pittsburgh (Pa.) Works immediately afterwards, and has been employed there since. Among the positions held by Mr. Monteith during that time were manager, industry engineering department; director of education; manager, headquarters engineering departments. He holds several patents for electric equipment he has developed, and is the author of numerous technical papers. He has been a member of the following AIEE committees: protective devices, technical program, planning and co-ordination, power generation, and Standards. Mr. Monteith has been chairman of the latter two. He also holds membership in these other societies and professional groups: American Society of Mechanical Engineers, American Standards Association, Conference Internationale Des Grands Reseaux Electriques, International Electrotechnical Commission, American Society for Engineering Education, and the National Electrical Manufacturers Association.

W. N. Goodwin, Jr. (A '06, F '13) consultant with the Weston Electrical Instrument Corporation, Newark, N. J., has completed 50 years of service with that company. He was graduated from the University of Pennsylvania in 1898 and joined the Weston Corporation immediately afterwards. He was selected as chief engineer and director of research in 1906, following his work on the basic mathematical equations for instrument design a method that placed the manufacturing of instruments on a scientific basis for the first time. Eventually he was elected vice-president in charge of research and engineering. Among Mr. Goodwin's more important developments were the thermo-ammeter for the measurement of radio frequency in 1915, and its successor several years later, the rectifier-type instrument. He also developed the Weston exposure meter and the co-ordinating Weston film rating system in 1932. Though officially retired, Mr. Goodwin still serves as a Weston consultant and continues his studies in the field of instrument design and advanced measurement theory. He has been on the AIEE instruments and measurements committee continuously since 1924, except for 1925, 1926, and 1931.

J. E. Hume (A '45) commercial vice-president of the General Electric Company, Schenectady, N. Y., has retired from the company after 41 years' service. Born near Alexandria, Va., Mr. Hume was graduated from the University of Virginia in 1906 with a bachelor of science degree in electrical engineering. The following year he joined General Electric on the test course at Schenectady, and after completing the course entered the switchboard engineering department. In 1911 he was transferred to the Baltimore office as a salesman, and returned to Schenectady the following year in the industrial department. Later he became manager of sales of the mining and steel section of that department. In 1928 Mr. Hume became manager of the motor division and the following year assistant manager of the entire industrial department. After being named manager of the department in 1935, he was elected a commercial vice-president of the company in 1938.

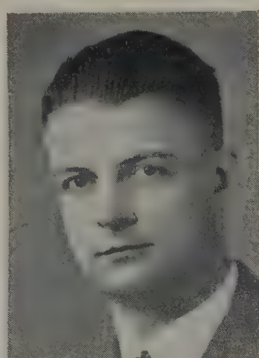
Edwin H. Krieg (M '47) former chief design engineer of the American Gas and Electric Corporation at New York, N. Y., has been appointed consulting engineer at the Boston (Mass.) office of Stone and Webster, effective September 1, 1948. Since his graduation as a mechanical engineer from Cornell University in 1922, Mr. Krieg continuously has been engaged in developing and designing power stations. From 1924 to 1925, he designed sugar mill plants in the Dominican Republic, Central America, followed by numerous steam-electric and Diesel-electric plant designs in the United States and South America between the years 1925 and 1933. Joining the American Gas and Electric Corporation immediately afterwards, Mr. Krieg was responsible for that company's mechanical designs for high-pressure power installations totaling approximately 2,000,000 kw in capacity. He is now a member of the AIEE nucleonics committee for 1947–48. Mr. Krieg is also a fellow of the American Society of Mechanical Engineers and has served for an umber of years on the prime movers committee of the Edison Electric Institute.

K. M. Irwin (M '46) formerly manager of the Philadelphia (Pa.) Electric Company's engineering department, has been elected vice-president of that company. He was graduated from the Yale-Sheffield Scientific School in 1915. After serving with the United States Navy in World War I he joined the United Gas Improvement Company as a mechanical engineer. He transferred to the Philadelphia Electric Company in 1931 and subsequently was appointed manager of the engineering department. During World War II he was executive director of the London staff, public utility committee of the combined production and resources board, which was concerned with the restoration of utility service in northwest Europe. In his new position he will be vice-president in charge of engineering.

D. J. Munhall (A '43) has been appointed sales representative in upper New York State for the Pennsylvania Transformer Company, Pittsburgh, Pa. A graduate of the University of Pennsylvania, Mr. Munhall was formerly sales engineer of the Union Carbide and Carbon Corporation in New York City and in Cleveland, Ohio. Before accepting his present appointment, he organized his

W. N. Goodwin, Jr.

E. H. Krieg



D. J. Munhall

own firm, the Douglas J. Munhall Company, Manufacturers' Representatives, Buffalo, New York.

E. F. Peterson (A '33, M '45) formerly in charge of design engineering of receiving tubes, engineering division, General Electric Company, Schenectady, N. Y., has been appointed assistant manager of the tube division. Mr. Peterson was graduated from the Kansas State University with a bachelor of science degree in electrical engineering in 1931, and a master of science degree in 1932. He was professor of physics at Sterling College, Sterling, Kans., from September 1932 until July 1933. In that year he became associated with the General Electric Company at Schenectady and worked in the test department. In 1934 he was transferred to the vacuum tube engineering department and in 1941 he became supervisor of quality control for the tube division. In 1943 he returned to the engineering division as section leader on receiving tubes.

H. E. Ives (F '29) research consultant of the Bell Telephone Laboratories, Inc., New York, N. Y., has received the Medal for Merit, representing the President's highest award to civilians, made for his work as head of a government research project during World War II. He was cited for his brilliant work in development of equipment using infrared rays. Among other recipients of this award was **Doctor C. G. Suits** (M '41) vice-president of the General Electric Company in charge of the research laboratories at Schenectady, N. Y., who was cited for his work as chief of the radio and radar countermeasures division. In this position he headed the efforts to defeat the enemy use of radio and radar communications. Also cited was **Doctor Zay Jeffries** (M '36, F '42) vice-president of General Electric in charge of the chemical department, Pittsfield, Mass. He was vice-chairman of the war metallurgy committee, the National Defense Research Committee.

Merwin M. Brandon (A '34, F '44) associate electrical engineer of the Underwriters' Laboratories, Inc., New York, N. Y., has been elected a vice-president. Mr. Brandon, a graduate of Mississippi State College, joined the Underwriters' Laboratories as an assistant engineer in 1921. In 1924, he became service engineer, and in 1927 was chief inspector. Since 1928, he has been in charge of original investigations and reports on electric devices and appliances submitted to Underwriter testing laboratories in New York, Chicago, Ill., and San Francisco, Calif. A member of the AIEE technical program, insulated conductors, and general applications co-ordinating committees during 1947–1948, Mr. Brandon has been chairman of the AIEE domestic and commercial applications committee (1947), and an executive officer of the AIEE Standards committee (1944–1947).

W. F. Hess (A '32, M '41) associate professor of metallurgical engineering, head of the welding laboratory, Rensselaer Polytechnic Institute, Troy, N. Y., received the 1948 Wetherill medal of the Franklin Institute, it was announced recently. The medal is awarded "in consideration of his outstanding contributions to the art and science of welding, notably in his field of electrical resistance welding" and will be presented to Hess by the president of the Franklin Institute, R. T. Nalle. Professor Hess received his doctor of engineering degree in 1928 from the Rensselaer Polytechnic Institute and was appointed instructor in electrical engineering and physics at the institute. He was soon advanced to the post of assistant professor, and in 1937 was transferred to the department of metallurgical engineering which recently had been established. In 1938 he was made associate professor and head of the welding laboratory. He became full professor in 1945 and head of the department of metallurgical engineering in 1947.

M. R. Hanna (A '03) engineer of the motor engineering division at the General Electric Company's Erie, Pa., works since 1926, retired in June after 45 years' service with the company. Mr. Hanna began his employment with General Electric in 1902 when he joined the general test program at Schenectady works. In 1905 he was transferred to the railway motor engineering department. In 1912 Mr. Hanna was placed in charge of electrical design in that department and in 1925 named head of the department. His title later was changed to engineer, motor division, the position he held until his retirement.

Samuel M. Dean (A '25, F '46) chief engineer of the system, The Detroit (Mich.) Edison Company, will be the next president of the Engineering Society of Detroit. A graduate of Michigan State College, Mr. Dean was with the General Electric Company, Schenectady, N. Y., for ten years before joining the Detroit Edison Company in 1924. He was a member of the AIEE power transmission and distribution committee from 1933 to 1934, and is, at present, chairman of the Edison Medal committee. A registered professional engineer, Mr. Dean also holds membership in the American Society of Mechanical Engineers and Tau Beta Pi fraternity.

O. E. Buckley (M '19, F '29) president of Bell Telephone Laboratories, Inc., New York, N. Y., has been appointed by President Truman to a 6-year term as member of the general advisory committee of the Atomic Energy Commission. The appointment was effective August 1, 1948. Members of the committee serve as advisors to the commission on scientific and technical matters relating to materials, production, and research, and development. Doctor Buckley served during World War II as member of the communications and guided missile divisions of the National Defense Research Committee. At the conclusion of the war he was awarded the Medal for Merit.

M. W. Smith (A '20, F '42) formerly vice-president in charge of engineering and research, Westinghouse Electric Corporation, Pittsburgh, Pa., has been elected executive vice-president of the Baldwin Locomotive Works, Eddystone, Pa. Mr. Smith is a graduate of Texas Agricultural and Mechanical College (1915), and was associated with Westinghouse for 33 years. During the period 1917–30, Mr. Smith was instrumental in many interesting developments among which were the 40,000-kva generating units for the Conowingo power project on the Susquehanna River. He was appointed division engineer at Westinghouse in 1930, and was named manager of engineering in 1936. He was elected vice-president in charge of engineering and research in 1939. In 1938 he won the Westinghouse order of merit with a medal and citation for his outstanding services.

J. E. Clem (A '19, M '30, F '38) central station engineering division, General Electric Company, Schenectady, N. Y., has been elected chairman of project 4 (field survey of and application problems associated with ground fault neutralizers) of the fault limiting devices subcommittee of the AIEE protective devices committee for 1948–49, and also has been appointed chairman of subcommittees 3 (instrument transformer subcommittee), 7 (working group on magnetization characteristics of transformers) and 12 (working group on co-ordination of insulation) of the AIEE transformers committee for 1948–49.

O. W. Pike (A '30, M '36) formerly engineer, tube division, General Electric Company, Schenectady, N. Y., has been appointed manager of engineering, tube division. Mr. Pike joined the General Electric Company in 1920 in the test department. In 1922 he transferred to the research laboratory and in 1930 he became a member of the vacuum tube department, later becoming design engineer of that department. In 1942, Mr. Pike was named engineer of the vacuum tube department, becoming engineer of the tube division in 1943.

A. A. Johnson (A '34, M '44) central station engineer, Westinghouse Electric Corporation, East Pittsburgh, Pa., has been appointed chairman of the fault limiting devices subcommittee and of project 2 (application guide on methods of grounding generator systems) of the AIEE protective devices committee for 1948–49, and also of subcommittees 4 (working group on accuracy of voltage regulator control devices), 5 (working group on operating guides for regulators), and 6 (working group on short-circuit thermal ratings of induction and step-type regulators) of the AIEE transformers committee for 1948–49.

Orrin W. Towner (A '28, M '35) technical director of radio station *WHAS*, Louisville, Ky., has received the Presidential Certificate of Merit for civilian activities in World War II. The certificate, signed by President Truman and Supreme Court Justice Owen J. Roberts, was given to Mr. Towner for his work with the air-borne instruments laboratory of Columbia University Division of War Research. Mr. Towner is a past chairman of the AIEE Louisville (Ky.) Section, and also holds membership in the Institute of Radio Engineers, the Acoustical Society of America, and the Society of Motion Picture Engineers.

Cherry L. Emerson (M '20, F '33) dean of engineering at the Georgia Institute of Technology, Atlanta, Ga., will hold the newly created office of vice-president in charge of research, extension, and construction at that school. The following institute divisions all will be under Dean Emerson under the new setup: the engineering experiment station, the engineering extension division, the buildings and grounds division, and the new construction division.

F. R. Lack (M '37) of the Western Electric Company, New York, N. Y., has been appointed chairman of the Radio Manufacturers' Association's 8-man industry mobilization committee. **R. C. Sprague** (M '40) of the Sprague Electric Company, North Adams, Mass., is also a member. Objectives of the committee will be to persuade government officials to establish a committee to centralize and co-ordinate procurement of equipment and components, and to expedite production of equipment intended for military use.

Henry B. Wood (A '19, F '38) chief electrical engineer of the Stone and Webster Engineering Corporation, Boston, Mass., has been awarded the honorary degree of doctor of engineering by Purdue University, Lafayette, Ind. In conferring the degree, the university characterized Doctor Wood as a "distinguished engineer and executive, recognized for his contributions to our knowledge and control of electrical power, honored for service to our nation during two wars." Doctor Wood was a member of the AIEE protective devices committee from 1930 to 1934.

M. J. Kelly (M '26, F '31) executive vice-president of the Bell Telephone Laboratories, Inc., New York, N. Y., has been named chairman of the new Committee on Navigation which will work closely with the Air Navigation Development Board.

J. F. McAllister (A '40) has been appointed designing engineer in the specialty division of the General Electric Company. He has been on the design staff of that company since 1939, and with his new position, will be responsible for the design of precision testing units and devices for use in radio and electronics.

M. E. Skinner (A '18, M '46) has been named vice-president in charge of commercial operations, and **Dudley Sanford** (A '25) has been named vice-president in charge of electric operations for the Union Electric Company, St. Louis, Mo. Mr. Skinner was on the AIEE membership committee from 1921 to 1924, acting as its chairman in 1923 and 1924, and was a member of the AIEE special committee on Institute prizes for 1935 and 1936.

Edwin S. Bundy (A '14, F '33) former director, vice-president, and chief engineer of the Buffalo Niagara Electric Corporation, Buffalo N. Y., has been elected vice-president and chief engineer of the Niagara Hudson Power Corporation, Syracuse, N. Y. Mr. Bundy was on the AIEE electric machinery committee from 1931 to 1938, and on the AIEE power transmission and distribution committee from 1932 to 1936.

W. A. McMorris (A '30, M '37) General Electric Company, Pittsfield, Mass., has been appointed chairman of project 6 (performance characteristics of station type lightning arresters) of the lightning protective devices subcommittee of the AIEE protective devices committee for 1948–49.

J. R. McFarlin (A '07, M '26) secretary and electrical engineer, Electric Service Manufacturing Company, Philadelphia, Pa., has been appointed chairman of project 7 (performance characteristics of valve type distribution lightning arresters) of the lightning protective devices subcommittee of the AIEE protective devices committee for 1948–49.

R. H. Earle (A '27, M '29) research engineer, Line Material Company, South Milwaukee, Wis., has been appointed chairman of project 8 (performance characteristics of 20 to 73 kv line type lightning arresters) of the lightning protective devices subcommittee of the AIEE protective devices committee for 1948–49.

R. L. Witzke (A '37, M '45) central station engineer, industry engineering department, Westinghouse Electric Corporation, East Pittsburgh, Pa., has been appointed chairman of project 9 (joint working group—with general systems subcommittee of the transmission and distribution committee—on recovery voltage characteristics of distribution systems) of the lightning protective devices subcommittee of the AIEE protective devices committee for 1948–49.

A. M. Opsahl (A '26, M '41) switchgear engineering department, Westinghouse Electric Corporation, East Pittsburgh, Pa., has been appointed chairman of project 10 (performance characteristics of line expulsion arresters) of the lightning protective devices subcommittee of the AIEE protective devices committee for 1948–49.

E. H. Grosser (A '45) engineer, Commonwealth Edison Company, Chicago, Ill., has been appointed chairman of project 11 (combined performance characteristics of lightning protective devices) of the lightning protective devices subcommittee of the AIEE protective devices committee for 1948–49.

Milan Getting (A '37) superintendent, test department, Allis-Chalmers Manufacturing Company, Pittsburgh, Pa., has been appointed chairman of project 12 (status of rod gap characteristics) of the lightning protective devices subcommittee of the AIEE protective devices committee for 1948–49.

E. M. Hunter (A '28, M '36, F '48) central station engineering division, General Electric Company, Schenectady, N. Y., has been appointed chairman of project 1 (application guide on methods of grounding transmission systems) of the fault limiting devices subcommittee of the AIEE protective devices committee for 1948–49.

H. R. Paxson (A '25, M '40) senior engineer, in charge of protective relays, Philadelphia (Pa.) Electric Company, has been appointed chairman of subcommittee 2 (project committee on generator protection) of the AIEE relay committee for 1948–49.

G. B. Dodds (A '29, M '45) relay protection and section engineer, planning and development department, Duquesne Light Company, Pittsburgh, Pa., has been appointed an AIEE sponsor of subcommittee 3 (project committee or co-ordination of construction and protection of distribution circuits—joint with distribution subcommittee and Edison Electric Institute) of the AIEE relay committee for 1948–49.

E. L. Harder (A '30, M '41) central station engineer, Westinghouse Electric Corporation, East Pittsburgh, Pa., has been appointed chairman of subcommittee 6 (project committee on transmission line protection) of the AIEE relay committee for 1948–49, and of the continuous variable computers subcommittee of the AIEE computing devices committee for 1948–49.

A. J. McConnell (A '36) central station engineering divisions, General Electric Company, Schenectady, N. Y., has been appointed chairman of subcommittee 7 (project committee on electronic relay applications) of the AIEE relay committee for 1948–49.

E. L. Michelson (A '37, M '44) senior engineer, Commonwealth Edison Company, Chicago, Ill., has been appointed chairman of subcommittee 8 (project committee on insulation levels of relay and control circuit) and of subcommittee 10 (project committee on relay protection for stations without high-voltage switching) of the AIEE relay committee for 1948–49.

K. N. Reardon (M '45) switchgear engineer, West Penn Power Company, Pittsburgh, Pa., has been appointed chairman of subcommittee 9 (project committee on relaying of interconnections between industrial and utility generating systems of the AIEE relay committee for 1948–49.

C. E. Kilbourne (A '29, M '37) designing engineer, motor and generator engineering department, General Electric Company, Schenectady, N. Y., has been appointed chairman of the administrative subcommittee of the AIEE rotating machinery committee for 1948–49, of which he is also chairman.

E. I. Pollard (A '35, M '45) manager of engineering, The Elliot Company, Ridgway, Pa., has been appointed chairman of the synchronous machinery subcommittee of the AIEE rotating machinery committee for 1948–49.

C. W. Mayott (A '13, M '43) Hartford (Conn.) Electric Light Company, has been appointed chairman of the interconnection contracts subcommittee of the AIEE system engineering committee for 1948–49.

V. M. Montsinger (A '14, M '24, F '29) research engineer, power transformer engineering department, General Electric Company,

Pittsfield, Mass., has been appointed chairman of subcommittees 1 (working group on co-ordinated study of life of transformer insulation), 9 (working group on temperature limits of silicon insulation used in transformers) and 10 (working group on proposed revision of ASA rules in connection with short-circuit requirements of transformers), all of the AIEE transformers committee for 1948–49.

W. C. Sealey (A '25, M '38) Allis-Chalmers Manufacturing Company, Milwaukee, Wis., has been appointed chairman of subcommittee 2 (working group on routine measurement of hot spot temperature rise) of the AIEE transformers committee for 1948–49.

F. J. Vogel (A '21, M '41) research professor of electrical engineering, Illinois Institute of Technology, Chicago, has been appointed chairman of subcommittee 8 (working group on revision of dielectric tests) of the AIEE transformers committee for 1948–49.

J. A. Adams (A '24, M '43) senior engineer, connections and control group, engineering department, Philadelphia (Pa.) Electric Company, has been appointed chairman of subcommittee 11 (working group on care and operation of dry type transformers) of the AIEE transformers committee for 1948–49.

F. V. Smith (A '23, M '38) chief electrical engineer, Sargent and Lundy, Chicago, Ill., has been appointed chairman of the capacitor subcommittee of the AIEE transmission and distribution committee for 1948–49.

Harold Cole (A '19, M '27) chief planning engineer, Detroit (Mich.) Edison Company, has been appointed chairman of the distribution subcommittee of the AIEE transmission and distribution committee for 1948–49.

S. B. Crary (A '31, M '37, F '45) analytical division, central station engineering division, General Electric Company, Schenectady, N. Y., has been appointed chairman of the general systems subcommittee of the AIEE transmission and distribution committee for 1948–49.

J. T. Lusignan (A '27, M '34) engineering department, Ohio Brass Company, Mansfield, has been appointed chairman of the lightning and insulator subcommittee of the AIEE transmission and distribution committee for 1948–49, and is also chairman of the subcommittee on revision of AIEE Standard 4 (measurement of test voltage in dielectric tests) of the AIEE instruments and measurements committee for 1948–49.

T. M. Linville (A '27, M '34, F '47) electrical engineer, motor and generator engineering department, General Electric Company, Schenectady, N. Y., has been appointed chairman of the d-c machinery subcommittee of the AIEE rotating machinery committee for 1948–49.

M. L. Schmidt (A '37, M '43) section engineer, fractional horsepower motor engineering division, General Electric Company, Fort Wayne, Ind., has been appointed chairman of the single-phase and fractional horsepower subcommittee of the AIEE rotating machinery committee for 1948–49.

J. L. Fuller (A '37, M '45) experimental engineer, Reliance Electric and Engineering Company, Cleveland, Ohio, has been appointed chairman of the test code subcommittee of the AIEE rotating machinery committee for 1948–49.

R. W. Wieseman (A '18, M '26) motor and generator engineering division, General Electric Company, Schenectady, N. Y., has been appointed chairman of the insulation resistance subcommittee of the AIEE rotating machinery committee for 1948–49.

C. H. Black (A '41, M '45) assistant to manager, engineering department, General Electric Company, Philadelphia, Pa., has been appointed chairman of the circuit breaker subcommittee of the AIEE switchgear committee for 1948–49.

H. V. Nye (A '20, F '40) engineer in charge, switchgear design, Allis-Chalmers Manufacturing Company, West Allis, Wis., has been appointed chairman of the switchgear assemblies subcommittee of the AIEE switchgear committee for 1948–49.

H. H. Rudd (A '18, M '46) vice-president, Railway and Industrial Engineering Company, Greensburg, Pa., has been appointed chairman of the switches, fuses, and insulators subcommittee of the AIEE switchgear committee for 1948–49.

K. J. Falck (A '28, M '43) senior engineer, engineering department, Philadelphia (Pa.) Electric Company, has been appointed chairman of the subcommittee on high-voltage switching—where out of phase voltages exist at time of arc interruption—of the AIEE switchgear committee for 1948–49.

H. L. Harrington (M '34) system load supervisor, Buffalo, Niagara and Eastern Power Corporation, Buffalo, N. Y., has been appointed chairman of the system planning subcommittee of the AIEE system engineering committee for 1948–49.

O. W. Manz, Jr. (M '34) Consolidated Edison Company of New York, N. Y., Inc., has been appointed chairman of the system operations subcommittee of the AIEE system engineering committee for 1948–49.

A. P. Hayward (A '30) investigating engineer, power stations department, Duquesne Light Company, Pittsburgh, Pa., has been appointed chairman of the system economics subcommittee of the AIEE system engineering committee for 1948–49.

R. Brendt (A '26) engineering operating department, New England Power Company, Boston, Mass., has been appointed chairman of the system controls subcommittee of the AIEE system engineering committee for 1948–49.

W. E. Pakala (A '38, M '45) liaison engineer, engineering laboratories and standards department, Westinghouse Electric Corporation, East Pittsburgh, Pa., has been appointed chairman of the subcommittee on basic principles of altitude rating of electric apparatus of the AIEE air transportation committee for 1948–49.

L. A. Burckmyer (A '32, M '41) professor of electrical engineering, Cornell University Ithaca, N. Y., has been appointed chairman of the subcommittee on master test code for temperature measurements of the AIEE instruments and measurements committee for 1948–49.

H. C. Koenig (A '18, M '30) engineer-in-charge, electrical department, Electrical Testing Laboratories, New York, N. Y., has been appointed chairman of the subcommittee on revision of C 39 (electric indicating instruments) of the AIEE instruments and measurements committee for 1948–49.

W. G. Knickerbocker (A '20, M '30, F '46) superintendent of meters, Detroit (Mich.) Edison Company, has been appointed chairman of the subcommittee on watt-hour meters of the AIEE instruments and measurements committee for 1948–49.

G. W. Dunlap (A '35, M '42, F '48) general engineering and consulting laboratory, General Electric Company, Schenectady, N. Y., has been appointed chairman of the nucleonics instrumentation and control subcommittee of the AIEE nucleonics committee for 1948–49, and is also chairman of the joint subcommittee on nucleonic instruments (joint with nucleonics and instruments and measurements committees) for 1948–49.

D. E. Fritz (A '43) design engineer, aviation engineering department, Westinghouse Electric Corporation, Lima, Ohio, has been appointed chairman of the aircraft electric rotating machinery subcommittee of the AIEE air transportation committee for 1948–49.

W. F. Moore (A '47) aviation division, General Electric Company, Schenectady, N. Y., has been appointed chairman of the aircraft systems subcommittee of the AIEE air transportation committee for 1948–49.

L. W. Birch (A '20, M '29) engineer transportation department, Ohio Brass Company, Mansfield, has been appointed chairman of the heavy traction electrification data subcommittee of the AIEE land transportation committee for 1948–49.

H. F. Brown (A '10, M '25, F '47) electric traction engineer, New York, New Haven and Hartford Railroad, New Haven, Conn., has been appointed chairman of the heavy traction papers and plans subcommittee of the AIEE land transportation committee for 1948–49.

W. J. Clardy (M '39) engineer, industry engineering department, Westinghouse Electric Corporation, East Pittsburgh, Pa., has been appointed chairman of the light traction papers and plans subcommittee of the AIEE land transportation committee for 1948–49.

F. H. Craton (A '31, M '38) manager, industrial haulage division, General Electric Company, Erie, Pa., has been appointed chairman of the subcommittee on revision of AIEE Standard 16 (electric railway control apparatus) ASA C48 subcommittee, of the AIEE land transportation committee for 1948–49.

Clarence Lynn (A '38, M '43) manager, d-c generating engineering, Westinghouse Electric Corporation, East Pittsburgh, Pa., has been appointed chairman of the power generation subcommittee of the AIEE marine transportation committee for 1948–49.

W. N. Zippler (A '20, M '38) chief electrical engineer, Gibbs and Cox, Inc., naval architects and marine engineers, New York, N. Y., has been appointed chairman of the wires and cables subcommittee of the AIEE marine transportation committee for 1948–49, and is also chairman of the editing subcommittee of the same committee.

H. C. Coleman (A '18, M '28) manager, marine engineering department, Westinghouse Electric Corporation, East Pittsburgh, Pa., has been appointed chairman of the switchboards and control subcommittee of the AIEE marine transportation committee for 1948–49.

J. B. Feder (A '17, M '41, F '47) commander, United States Coast Guard, Merchant Marine Technical Division, Washington, D. C., has been appointed chairman of the fittings and appliances subcommittee of the AIEE marine transportation committee for 1948–49.

W. H. Reed (A '26, M '43) electrical engineer, Bruce Electric Company, New York, N. Y., has been appointed chairman of the communications and alarm subcommittee of the AIEE marine transportation committee for 1948–49.

S. N. Mead (M '45) vice-president, Henschel Corporation, Amesbury, Mass., has been appointed chairman of the navigation equipment subcommittee of the AIEE marine transportation committee for 1948–49.

R. A. Beekman (A '13, M '27) manager, federal and marine engineering division, General Electric Company, Schenectady, N. Y., has been appointed chairman of the publicity, personnel, and history subcommittee of the AIEE marine transportation committee for 1948–49.

A. J. Dusault (A '46) Westinghouse Lamp Division, Bloomfield, N. J., has been appointed chairman of the ultraviolet radiations subcommittee of the production and application of light committee for 1948–49.

E. H. Browning, Jr. (A '43) Westinghouse Electric Corporation, East Pittsburgh, Pa., has been appointed chairman of the arc furnaces and electrothermal processes subcommittee of the AIEE chemical, electrochemical, and electrothermal committee for 1948–49.

E. L. Kirk (A '40, M '45) engineer, Dow Chemical Company, Midland, Mich., has been appointed chairman of the cathodic protection subcommittee of the AIEE chemical, electrochemical, and electrothermal committee for 1948–49.

W. E. Gutzwiller (A '30, M '40) sales engineer, in charge of rectifier sales, electrical department, Allis-Chalmers Manufacturing Company, Milwaukee, Wis., has been appointed chairman of the electrolytic processes subcommittee of the AIEE chemical, electrochemical, and electrothermal committee for 1948–49.

L. O. Grondahl (A '26, M '42, F '47) research and engineering department, Union Switch and Signal Corporation, Swissvale, Pa., has been appointed chairman of the metallic rectifiers subcommittee of the AIEE chemical, electrochemical, and electrothermal committee for 1948–49.

L. M. Goldsmith (M '26, F '47) chief engineer, Atlantic Refining Company, Philadelphia, Pa., has been appointed chairman of the petroleum refining and production subcommittee of the AIEE chemical, electrochemical, and electrothermal committee for 1948–49, and is also chairman of the power application subcommittee of the AIEE marine transportation committee for 1948–49.

H. C. Riggs (A '42) manager of research, Electric Storage Battery Company, Philadelphia, Pa., has been appointed chairman of the storage batteries subcommittee of the AIEE chemical, electrochemical, and electrothermal committee for 1948–49.

L. W. Roush (A '43) chief electrical engineer, electrical engineering department, Carbide and Carbon Chemicals Corporation, South Charleston, W. Va., has been appointed chairman of the chemical industries subcommittee of the AIEE chemical, electrochemical, and electrothermal committee for 1948–49.

W. C. Rudd (A '34) chief engineer, engineering department, Induction Heating Corporation, New York, N. Y., has been appointed chairman of the electronic heating subcommittee of the AIEE electric heating committee for 1948–49.

P. H. Goodell (A '40, M '46) industrial heating engineer, The Trumbull Electric Manufacturing Company, Plainfield, Conn., has been appointed chairman of the radiant heating subcommittee of the AIEE electric heating committee for 1948–49.

R. M. Baker (A '28, M '40) industrial electronics division, Westinghouse Electric Corporation, Lansdowne, Md., has been appointed chairman of the subcommittee on radiation measurements above 200 megacycles of the AIEE electric heating committee for 1948–49.

L. P. Hynes (M '24, F '43) owner and chief engineer, Hynes Electric Heating Company, Camden, N. J., has been appointed chairman of the resistance heating and electric furnaces subcommittee of the AIEE electric heating committee for 1948–49.

C. M. Rhoades, Jr., (A '44) industrial engineering division, General Electric Company, Schenectady, N. Y., has been appointed chairman of the power supply for resistance welding machines subcommittee of the AIEE electric welding committee for 1948–49.

A. E. Davison (A '13, M '44) transmission engineer, Hydro-Electric Power Commission, Toronto, Ontario, Canada, has been appointed chairman of the towers, poles, and conductors subcommittee of the AIEE transmission and distribution committee for 1948–49.

Clyde E. Smith (M '44) chief electrical engineer, Taylor-Winfield Corporation, Warren, Ohio, has been appointed chairman of the resistance welding subcommittee of the AIEE electric welding committee for 1948–49.

E. F. Steinert (A '30) welding apparatus engineering, Westinghouse Electric Corporation, Buffalo, N. Y., has been appointed chairman of the arc welding subcommittee of the AIEE electric welding committee for 1948–49.

W. B. Wigton (A '40) electrical engineer, Cincinnati (Ohio) Planer Company has been appointed chairman of the machine tools subcommittee of the AIEE general industry applications committee for 1948–49.

E. M. Hayes (A '40) electrical engineer, crane and bridge department, Dravo Corporation, Pittsburgh, Pa., has been appointed chairman of the materials handling subcommittee of the AIEE general industry applications committee for 1948–49.

G. W. Knapp (A '45) engineer, paper and textile division, industrial engineering divisions, General Electric Company, Schenectady, N. Y., has been appointed chairman of the pulp and paper industry subcommittee of the AIEE general industry applications committee for 1948–49.

K. W. John (A '29, M '41) electrical engineer, United States Rubber Company, Detroit, Mich., has been appointed chairman of the rubber and plastics industries subcommittee of the AIEE general industry applications committee for 1948–49.

F. D. Snyder (A '45) textile engineer, Westinghouse Electric Corporation, Boston, Mass., has been appointed chairman of the textile industry subcommittee of the AIEE general industry applications committee for 1948–49.

E. H. Salter (A '23, M '29) research engineer, Electrical Testing Laboratories, Inc., New York, N. Y., has been appointed chairman of the nomenclature of electronic lamps subcommittee of the AIEE production and application of light committee for 1948–49.

E. A. Lindsay (A '43) electrical engineer, General Electric Company, Cleveland, Ohio, has been appointed chairman of the infrared radiations subcommittee of the production and application of light committee for 1948–49.

Giuseppe Calabrese (A '25, M '40) assistant engineer, system engineering department, Consolidated Edison Company of New York, N. Y., Inc., has been appointed chairman of the AIEE joint subcommittee on application

of probability methods to capacity problems (joint with power generation and system engineering committees) for 1948–49.

V. P. Hessler (A '29, M '36, F '43) department of electrical engineering, University of Illinois, Urbana, has been appointed chairman of the AIEE joint subcommittee on carbon brushes (joint with rotating machinery and air transportation committees) for 1948–49.

J. G. Reid, Jr. (A '47, M '48) division 13, section 6, National Bureau of Standards, Washington, D. C., has been appointed chairman of the AIEE joint subcommittee on electronic instruments (joint with electronics and instruments and measurements) for 1948–49.

C. K. Duff (A '28, M '41) meter engineer, operating department, Hydro-Electric Power Commission of Ontario, Toronto, Ontario, Canada, has been appointed chairman of the AIEE joint subcommittee on telemetering (joint with substation and instruments and measurements committee) for 1948–49.

H. H. Haglund (M '28) apparatus engineer, engineering department, Western Union Telegraph Company, New York, N. Y., has been appointed chairman of the record communications subcommittee of the AIEE communication committee for 1948–49.

J. W. Mauchly (M '48) Eckert-Mauchly Computer Corporation, Philadelphia, Pa., has been appointed chairman of the digital computers subcommittee of the AIEE computing devices committee for 1948–49.

D. G. Fink (M '45) executive editor, *Electronics*, McGraw-Hill Publishing Company, Inc., New York, N. Y., has been appointed chairman of the electronic aids to navigation subcommittee of the AIEE electronics committee for 1948–49.

R. C. Mason (A '26, M '37) Westinghouse Research Laboratories, East Pittsburgh, Pa., has been made chairman of the electronic precipitation subcommittee of the AIEE electronics committee for 1948–49.

W. C. White (A '23, M '30) research laboratory, General Electric Company, Schenectady, N. Y., has been appointed chairman of the electronic papers, meetings and section contacts subcommittee of the AIEE electronics committee for 1948–49.

G. J. Crowdes (A '21, F '46) assistant chief electrical engineer, Simplex Wires and Cable Company, Cambridge, Mass., has been appointed chairman of the high-frequency conductors, cables, and connectorssub committee of the AIEE electronics committee for 1948–49.

D. E. Trucksess (M '40) member of technical staff, power apparatus development department, Bell Telephone Laboratories, Inc., New York, N. Y., has been appointed chairman of the hot-cathode electronic power converters subcommittee of the AIEE electronics committee for 1948–49.

R. S. Burnap (A '17, M '29) manager, commercial engineering section, RCA Victor division, Radio Corporation of America, Harrison, N. J., has been appointed chairman of the subcommittee for liaison with Institute of Radio Engineers of the AIEE electronics committee for 1948–49.

O. W. Pike (A '30, M '36) engineer, tube division, electronics department, General Electric Company, Schenectady, N. Y., has been appointed chairman of the subcommittee for liaison with the Joint Electron Tube Engineering Council of the AIEE electronics committee for 1948–49.

W. H. Pickering (A '40) assistant professor of electrical engineering, California Institute of Technology, Pasadena, has been appointed chairman of the West Coast subcommittee of the AIEE electronics committee for 1948–49.

F. N. Tompkins (A '18, F '44) associate professor of electrical engineering, Brown University, Providence, R. I., has been made chairman of the electronic education subcommittee of the AIEE electronics committee for 1948–49.

W. A. Geohegan (M '47) department of anatomy, Cornell University Medical College New York, N. Y., has been appointed chairman of the subcommittee on electronic aids to medicine of the AIEE electronics committee for 1948–49.

S. W. Smith (M '47) National Bureau of Standards, Washington, D. C., has been appointed chairman of the X-ray tubes subcommittee of the AIEE electronics committee for 1948–49.

H. C. Steiner (A '32, M '44) electronics department, tube division, General Electric Company, Schenectady, N. Y., has been appointed chairman of the electron tubes subcommittee of the AIEE electronics committee for 1948–49.

Thomas Spooner (A '12, F '29) manager, engineering laboratories and standards department, Westinghouse Electric Corporation, East Pittsburgh, Pa., has been appointed chairman of the electronic standards subcommittee of the AIEE electronics committee for 1948–49, and of the joint subcommittee on standard frequency bands and designations for 1948–49.

C. L. Dawes (A '12, M '15, F '35) associate professor of electrical engineering, Harvard University, Cambridge, Mass., has been appointed chairman of the subcommittee on definitions of the AIEE instruments and measurements committee for 1948–49.

F. C. Doble (A '12, F '47) president and general manager, Doble Engineering Company, Medford Hillside, Mass., has been appointed chairman of the subcommittee on electrical tests on dielectrics in the field of the AIEE instruments and measurements committee for 1948–49.

F. J. Gaffney (A '37) chief engineer, Polytechnic Research and Development Company, Brooklyn, N. Y., has been appointed chairman of the subcommittee on high-frequency measurements of the AIEE instruments and measurements committee for 1948–49.

A. B. Craig (A '27, M '33) head, meter section, transmission and distribution department, Boston (Mass.) Edison Company, has been appointed chairman of the subcommittee on marking of varmeters and related instruments of the AIEE instruments and measurements committee for 1948–49.

F. B. Silsbee (A '13, M '26, F '42) chief, electrical instruments section, National Bureau of Standards, Washington, D. C., has been appointed chairman of the subcommittee on master test code for resistance measurements of the AIEE instruments and measurements committee for 1948–49.

R. W. Jones (A '38, M '45) department of electrical engineering, Northwestern University, Evanston, Ill., has been appointed chairman of bibliography subcommittee of the AIEE industrial control committee for 1948–49.

H. L. Palmer (A '42) engineer, industrial electronics, General Electric Company, Schenectady, N. Y., has been appointed chairman of the electronic control subcommittee of the AIEE industrial control committee for 1948–49.

G. W. Heumann (A '44, M '46) industrial control engineer, General Electric Company, Schenectady, N. Y., has been appointed chairman of the Standards subcommittee of the AIEE industrial control committee for 1948–49.

C. T. Evans (A '11, M '20, F '47, member for life) development engineer, Cutler-Hammer, Inc., Milwaukee, Wis., has been appointed chairman of the test codes subcommittee of the AIEE industrial control committee for 1948–49.

B. F. Thomas, Jr., (A '14, M '29) chief electrical and mechanical engineer, Moran, Proctor, Freeman and Meuser, consulting engineers, New York, N. Y., has been appointed chairman of the subcommittee on interior wiring design for commercial buildings of the AIEE industrial power systems committee for 1948–49.

John Grotzinger (A '24, M '44) manager, electrical engineering division, Goodyear Tire and Rubber Company, Akron, Ohio, has been appointed chairman of the subcommittee on revision of electric power distribution for industrial plants of the AIEE industrial power systems committee for 1948–49.

H. G. Barnett (A '33, M '41) central station engineer, Westinghouse Electric Corporation, East Pittsburgh, Pa., has been appointed chairman of the transformer voltage ratios subcommittee of the AIEE industrial power systems committee for 1948–49.

T. B. Montgomery (A '36, M '41) electrical department, Allis-Chalmers Manufacturing Company, West Allis, Wis., has been ap-

pointed chairman of the metal industries subcommittee of the AIEE mining and metal industry committee for 1948–49.

A. C. Muir (A '25, M '39) electrical engineer, Berwind-White Coal Mining Company, Philadelphia, Pa., has been appointed chairman of the mining subcommittee of the AIEE mining and metal industry committee for 1948–49.

M. G. Malti (A '24, M '45) professor of electrical engineering, Cornell University, Ithaca, N. Y., has been appointed chairman of the applied mathematics subcommittee of the AIEE basic sciences committee for 1948–49.

J. G. Brainerd (M '39) professor, Moore school of electrical engineering, University of Pennsylvania, Philadelphia, Pa., has been appointed chairman of the electric circuit theory subcommittee of the AIEE basic sciences committee for 1948–49.

W. A. Lewis, Jr., (A '27, F '45) consultant in electrical engineering, Armour Research Foundation, Illinois Institute of Technology, Chicago, has been appointed chairman of the energy sources subcommittee of the AIEE basic sciences committee for 1948–49.

J. A. Becker (F '43) research physicist, Bell Telephone Laboratories, Inc., Murray Hill, N. J., has been appointed chairman of the electrical properties of solids subcommittee of the AIEE basic sciences committee for 1948–49.

T. D. Yensen (A '09, M '23, member for life) manager, magnetic department, research laboratory, Westinghouse Research Laboratories, East Pittsburgh, Pa., has been appointed chairman of the subcommittee on magnetics of the AIEE basic sciences committee for 1948–49.

G. H. Gray (A '12, M '29) transmission engineer, general technical department, International Telephone and Telegraph Corporation, New York, N. Y., has been appointed chairman of the communications standards subcommittee of the AIEE communication committee for 1948–49.

A. J. Busch (A '24, M '30) member of the technical staff, Bell Telephone Laboratories, Inc., New York, N. Y., has been appointed chairman of the communication switching systems subcommittee of the AIEE communication committee for 1948–49.

H. A. Affel (A '18, M '23, F '41) director, transmission development department, Bell Telephone Laboratories, New York, N. Y., has been appointed chairman of the wire communications systems subcommittee of the AIEE communication committee for 1948–49.

E. G. Ports (A '26, M '34, F '46) assistant manager and chief engineer, radio equipment division, Federal Telephone and Radio Corporation, Newark, N. J., has been appointed chairman of the radio communication systems subcommittee of the AIEE communication committee for 1948–49.

S. C. Spielman (A '48) Philco Radio Corporation, Philadelphia, Pa., has been appointed chairman of the home radio receivers subcommittee of the AIEE communication committee for 1948–49.

F. M. Rives (M '41) General Electric Company, Syracuse, N. Y., has been appointed chairman of the power line carrier systems subcommittee of the AIEE communication committee for 1948–49.

R. E. Shelby (A '36, M '44) development engineer, National Broadcasting Company, New York, N. Y., has been appointed chairman of the radiobroadcasting systems subcommittee of the AIEE communication committee for 1948–49.

G. H. Fiedler (M '47) Rochester (N. Y.) Gas and Electric Company, has been appointed chairman of the sheaths and coverings subcommittee of the AIEE insulated conductor committee for 1948–49.

L. I. Komives (A '41, M '43) electrical engineer, Detroit (Mich.) Edison Company, has been appointed chairman of the cable supply systems subcommittee of the AIEE insulated conductor committee for 1948–49.

G. T. Koger (M '47) General Electric Company, Bridgeport, Conn., has been appointed chairman of the utilization wiring systems subcommittee of the AIEE insulated conductor committee for 1948–49.

W. T. Peirce (A '32, M '35) chief cable engineer, American Steel and Wire Company, Worcester, Mass., has been appointed chairman of the special purpose cables subcommittee of the AIEE insulated conductor committee for 1948–49.

M. W. Ghen (A '26, M '39, F '48) superintendent of operations, downtown division, distribution department, Duquesne Light Company, Pittsburgh, Pa., has been appointed chairman of the accessories subcommittee of the AIEE insulated conductor committee for 1948–49.

R. S. Peterson (M '38) line installation engineer, Commonwealth Edison Company, Chicago, Ill., has been appointed chairman of the structures subcommittee of the AIEE insulated conductor committee for 1948–49.

Gordon Thompson (A '12, F '46) chief engineer, Electrical Testing Laboratories, Inc., New York, N. Y., has been appointed chairman of the tests and measurements subcommittee of the AIEE insulated conductor committee for 1948–49.

OBITUARY • • • •

Donald B. Hoseason (A '22, M '28) director of studies at the Administrative Staff College, Henley-on-Thames, England, died July 16, 1948. Mr. Hoseason was born in Leek, England, January 27, 1899, and received his technical training at the Municipal College of Technology, Manchester, England. He served his technical apprenticeship with the British Westinghouse Company, Ltd., from 1915 to 1920, and then joined the Metropolitan-Vickers Electrical Company as a designer of single and multiphase induction motors at the Trafford Park Works, Manchester, England. In 1922, Mr. Hoseason was appointed as advisory engineer and during the time he held that position, he developed several special rotating machines including the double-squirrel-cage motor, high-frequency converters, and phase advancers. He was made engineer in charge of motor development of the Metropolitan-Vickers Company in 1925, and after 1928, held the office of chief engineer. Recently, and until his death, Mr. Hoseason was in technical education.

Charles Callaway Wilson (M '43) assistant to the secretary of the AIEE at Institute headquarters, New York, N. Y., died August 12, 1948, at his home in Mount Vernon, N. Y. Mr. Wilson was born in Pueblo, Colo., on July 31, 1912. In 1933 he was graduated from Trinity College at Hartford, Conn., with a bachelor of science degree in engineering, and in 1935 he received a bachelor of science degree in electrical engineering from the Massachusetts Institute of Technology. In the latter year Mr. Wilson entered the employ of the Ward Leonard Electric Company, Mount Vernon, and was named electrical design engineer in 1937. In 1942 he was placed in charge of the design section of the engineering department and in this position supervised development on electric motor control apparatus for the United States Navy. He joined the AIEE headquarters staff as assistant to the secretary in 1946 to assist the technical committees. Mr. Wilson was a member of Sigma Xi.

Tudor Conway James (A '18, M '18) formerly system engineer in the municipal department of the Hydro-Electric Power Company of Ontario, Toronto, Canada, died at his home on July 3, 1948. Born June 24, 1880 at Sherbrooke, Quebec, Canada, Mr. James received his technical electrical training at the Bliss Electrical School, Washington, D. C. He served as electrical engineer with the Michigan and Lake Superior Power Company at their Sault Sainte Marie, Mich., plant in 1902, and in 1904 became superintendent of the Fox River Valley Gas and Electric Company in Wisconsin. Between 1905 and 1907, Mr. James was employed by both the Ontario Power Company at Niagara Falls, Canada, and the Bullock factory at Montreal of the Allis-Chalmers Company. In 1908, he joined the Toronto Hydro-Electric System as the superintendent of overhead construction and in 1912 was appointed Toronto district engineer for the Hydro-Electric Power Commission of Ontario. While on the commission staff, he was in charge of their Northern Ontario Properties, and the Georgian Bay and Thunder Bay systems. In this capacity, Mr. James was largely responsible for the growth of the hydro-electric load carried to the mining areas of northern Ontario.

Charles J. Holland Moritz (A '02, F '13) retired vice-president of the Aluminum Corporation of America, died June 27, 1948. He was born in Saginaw, Mich., in 1876. Upon receiving his degree in electrical engineering from the University of Michigan in 1897, Mr. Moritz became assistant engineer for the Valley Telephone Company in the Saginaw and Bay City areas of Michigan. After working as assistant engineer for the T. Pringle and Son Company of Montreal on their Shawinigan Falls development for two years, Mr. Moritz joined the Pittsburgh Reduction Company at Niagara Falls, N. Y. in 1901, and by 1907 had risen from construction engineer to superintendent in charge of carbon plant construction. He became superintendent for the erection and operation of reduction buildings and rolling mills at the Niagara works of the Aluminum Corporation of America in 1907, and it was while in this position that Mr. Moritz helped Charles Martin Hall perfect his method for extracting aluminum from bauxite ore. He became general superintendent of Alcoa's entire reduction system in 1912, and was elected a vice-president of the company in 1918. He retired from active service in 1931, and since then had been living in Buffalo, N. Y.

John E. Lawson (A '22) president of the Canadian Niagara Power Company, Ltd., Niagara Falls, Ontario, Canada, died July 23, 1948. He was born in Clinton, N. Y., on August 1, 1881, and took his technical training in the fields of electric lighting and railways. His early work in the electric power field was with the General Electric Company at Schenectady, N. Y., and in 1905, he joined the company which he later headed. Starting as an assistant electrician, he performed various duties until 1915, when he became chief operator at the company's hydroelectric power station. In 1921, he was named superintendent of the plant, a positon he held until being named a vice-president in 1933. Later that same year he also was named a director, and on March 20, 1946, he became president of the company. Mr. Lawson was also a member of the executive and managers' committees of the Canadian Electrical Association, and early in 1948 was made president of the Electrical Employers Association of Ontario. He was a director of the Ontario Associated Boards of Trade and Chamber of Commerce and a member of the professional engineers of the Province of Ontario.

Raymond Guy Littler (M '44) former owner and manager of the West Coast Engineering Company, Portland, Oreg., died in May. Born December 15, 1881, in Jonesboro, Ind., he entered the electrical field in 1899 with the Albany (Oreg.) Electric Light and Power Company. In 1900 he began a period of four years of electrical engineering work in Portland, and in 1905 he organized his own business, The West Coast Engineering Company, Portland, an electrical engineering and construction firm. In 1941, due to the difficulty of obtaining materials for private electrical construction work, Mr. Littler accepted a position in the defense project as chief electrical engineer under the firm of Stevens and Koon. He was connected with construction of the Umatilla Ordnance Depot at Hermiston, Oreg., a $25,000,000 project. Following completion of this project in 1942, Mr. Littler joined the Kaiser Company, Inc., Portland, as chief electrical engineer. He was concerned with the building of the complete power layout of the Kaiser Shipbuilding plant on Swan Island, Portland. He was also chief electrical engineer on marine works on shipbuilding. He previously was a member of the Institute from 1911 to 1935.

MEMBERSHIP

Applications for Election

Applications have been received at headquarters from the following candidates for election to membership in the Institute. Any member objecting to the election of any of these candidates should so inform the secretary before October 21, 1948, or December 21, 1948, if the applicant resides outside of the United States, Canada, or Mexico.

To Grade of Fellow

Israel, D. D., Emerson Radio & Phonograph Corp., New York, N. Y.
Metcalf, G. F., General Elec. Co., Syracuse, N. Y.

2 to grade of Fellow

To Grade of Member

Bailey, F. T., Westinghouse Elec. Corp., Buffalo, N. Y.
Benson, E. A., U. S. Bureau of Reclamation, Parker Dam, Calif.
Chamberlin, J. R., Jr., I-T-E Circuit Breaker Co., New York, N. Y.
Clavier, A. G., Federal Telecommunication Labs., Inc., New York, N. Y.
Davis, D. A., Cannon Elec. Development Co., Los Angeles, Calif.
Desbarats, G. H., Dept. Natural Resources, St. Johns, Newfoundland
Dossor, F., Elec. Cdr.R.N., British Joint Services Mission, Washington, D. C.
Downey, J. J., The Zia Co., Los Alamos, New Mexico
Fairchild, R. B., A. T. & T. Co., Philadelphia, Pa.
Guevara, E. J., Trinidad & Tobago Elec. Commission, Trinidad, British West Indies
Hall, F. L., Public Works, Hdqtrs. 13th Naval District, Seattle, Wash.
Hawley, D. C., Kansas City Power & Light Co., Kansas City, Mo.
Johannsen, K. L., Carnegie-Illinois Steel Corp., Duquesne, Pa.
Kasher, R. J., Line Material Co., Omaha, Nebr.
Liebermann, J., John Morris Electrical Eng. Co., Ltd., Bilston, Staffs, England
Loizides, N., Hellenic Co. of Chemical Products & Manures, Nicosia, Cyprus
Master, G. F., Allen-Bradley Co., Detroit, Mich.
O'Keefe, R. J., H. K. Ferguson Co., Houston, Tex.
Oldfeild, V. P., Beam Wireless Station, Yeravda, Poona, India
Phillips, H. W., Jr., Penna.-New Jersey Interconnection, Philadelphia, Pa.
Weber, H. A., U. S. Naval Ordnance Plant, Indianapolis, Ind.
Wilson, R. B., Mississippi Power & Light Co., Jackson, Miss.

22 to grade of Member

To Grade of Associate

United States, Canada, and Mexico

1. North Eastern

Deneen, G. E., General Elec. Co., Pittsfield, Mass.
Donnell, H. P., Eastman Kodak Co., Rochester, N. Y.
Gatzert, E. H., Stromberg Carlson Co., Rochester, N. Y.
Grover, N. J., Westinghouse Elec., Boston, Mass.
Harper, L. R., Intl. Business Machines Co., Endicott, N. Y.
Huboi, R. W., Eastman Kodak Co., Rochester, N. Y.
Ihle, D. M., General Elec. Co., West Lynn, Mass.
Meader, R. B., New England Tel. & Tel. Co., Boston, Mass.
Summers, E. W., Westinghouse Elec. Corp., Buffalo, N. Y.

2. Middle Eastern

Blum, S., Curtiss-Wright Corp., Columbus, Ohio
Boyer, R. W., Ohmer Corp., Dayton, Ohio
Demarest, D. M., Locke, Inc., Baltimore, Md.
Dickinson, C. J., I-T-E Circuit Breaker Co., Philadelphia, Pa.
Salinas, B. R., Gilbert Associates, Inc., Reading, Pa.
Tobe, S. S., U. S. Naval Base, Philadelphia, Pa.
Weir, E. V., Naval Ordnance Lab., Washington, D. C.

3. New York City

Coppage, L. F., The Kellex Corp., New York, N. Y.
Cozier, J. R., The Imperial Elec. Co., New York, N. Y.
Reigle, J., General Elec. Co., Trenton, N. J.
Stone, W. A., Rambusch Dec. Co., New York, N. Y.
Taylor, J. A., Sperry Gyroscope Co., Great Neck, N. Y.

4. Southern

Bailey, J. N., Jr., Buzzards Roost Power Plant, Greenwood, S. C.
Bird, F. S., The California Co., New Orleans, La.
Cannon, M. K., Jr. (re-election), General Elec. Co., Charlotte, N. C.
Giles, E. S., Clemson College, Clemson, S. C.
Johnson, T. C., Delta Electrical School, New Orleans, La.
Oliphant, G. W., Carbide & Carbon Chemical Co., Oak Ridge, Tenn.
Scott, J. R., Virginia Elec. & Power Co., Norfolk, Va.
Sosnowski, S. J., Jr., Carbide & Carbon Chemicals Corp., Oak Ridge, Tenn.
Tichenor, E. H., Kentucky Inspection Bureau, Louisville, Ky.
Tuttle, J. S., Carbide & Carbon Chemicals Corp., Oak Ridge, Tenn.
Wilkins, E. W., Tenn. Valley Authority, Chattanooga, Tenn.
Wilson, J., Tenn. Valley Authority, Knoxville, Tenn.

5. Great Lakes

Ailara, R. C., Commonwealth Edison Co., Chicago, Ill.
Brainin, S. M., Chicago Technical College, Chicago, Ill.
Carson, L. H., Northwestern Univ., Evanston, Ill.
Genda, P., Commonwealth Edison Co., Pekin, Ill.
Knight, R. L., Veterans Administration Branch #8, St. Paul, Minn.
Kottemann, W. C., Illinois Bell Tel. Co., Chicago, Ill.
North, J. C., Western Elec. Co., Inc., Chicago, Ill.
Storey, W. G., Kellogg Switchboard & Supply Co., Chicago, Ill.
Uhl, L. T., Eureka Williams Corp., Bloomington, Ill.

7. South West

Ballve, M. J., Sociedad Mexicana de Credito Industrial, S. A. Mexico, Federal District, Mexico
Bohme, E., Articulo 123 No. 22-Desp. 213, Mexico, Federal District, Mexico
Cabrera P, I. D. J., Instito Mexicano D. F. Illuminacion, Mexico City, Mexico
Canales, P. M., Mexican Light & Power Co., Mexico, Federal District, Mexico
Chism, J. H., Dallas Power & Light Co., Dallas, Tex.
Cortina B., G., Industria Electrica de Mexico, Mexico, Federal District, Mexico
Dobbins, F. E., Black & Veatch, Consulting Engrs., Kansas City, Mo.
Heiligmann, G., V., Mexican Light & Power Co., Mexico City, Mexico
Heuer, E. A., Articulo 123 No. 22-Desp. 213, Mexico, Federal District, Mexico
Kirkwood, T. C., A. C. Kirkwood & Assoc., Kansas City, Mo.
Lerch G., R. Gorman & Castro, S. A., Mexico, Federal District, Mexico
Saldana, L., Altos Hornos de Mexico, S. A., Monclova Coah, Mexico
Stenis, T. B., Texas Technological College, Lubbock, Tex.
Tapie, G., P., Comision Federal de Electricidad, Mexico, Federal District, Mexico
Wilson, J. H., Emerson Elec. Mfg., St. Louis, Mo.

8. Pacific

Cook, A. L., Northrop Aircraft Co., Hawthorne, Calif.
Gally, S. K., Southern California Gas Co., Los Angeles, Calif.
Harger, V. R., Jr., U. S. Naval Ordnance, Pasadena, Calif.
McAlister, R. P., Cannon Elec. Development Co., Los Angeles, Calif.
Parker, W. H., Jr., U. S. Bureau of Reclamation, Phoenix, Ariz.
Willis, J. L., City of Mesa, Mesa, Ariz.

9. North West

Arnold, E. F., Portland General Elec. Co., Portland, Oreg.
Mason, H. C., Fir Mfg. Co., Myrtle Creek, Oreg.
Tribble, L. B., General Elec. Supply Corp., Butte, Mont.
Viehmann, E. G., Montana Power Co., Butte, Mont.

10. Canada

Duffy, F. H., Aluminum Co. of Canada, Shipshaw, Quebec, Canada

Elsewhere

Chang, H.-C., Central Elec. Corp. of China, Hsiangtan, Hunan, China
Dattatraya, M. P., c/o The Associated Cement Cos. Ltd., Bombay, India
Fairey, A. R. (re-election), Fairey Electrical & Eng. Co., Co., Ltd., Auckland, New Zealand
Miranda, I. M., The Ahmedabad Electricity Co., Ltd., Ahmedabad, India
Ramabhadran, S., Thomson College of Engineering, Roorkee, U. P., India
Sarkar, N., University College of Science & Technology, Calcutta, India
Scott, M. R., Electo-Mecanica Paulista S./A., Sao Paulo, Brazil, South America
Sen, G. S., Government of West Bengal, Calcutta, India
Sobti, R. L., Metal & Steel Factory, Ishapore, West Bengal, India
Varma, G. K. R., Hydel, P. W. D., Muhammadpur Falls, Dist. Saharanpur, U. P., India

Total to grade of Associate
United States, Canada, and Mexico, 68
Elsewhere, 10

OF CURRENT INTEREST

Program Plans Completed for National Electronics Conference

Final plans have been completed for the 1948 National Electronics Conference which will be held at the Edgewater Beach Hotel, Chicago, Ill., November 4–6, 1948. A comprehensive technical program has been arranged covering such major fields of interest as new materials, sound measurement and recording, servomechanisms, electronic instrumentation, communications, new tube developments, microwaves, television, computors, industrial applications, management of research, electronic circuits, and magnetic amplifiers and antennas. A list of the technical papers to be presented is given in the following. Further information concerning the conference may be obtained from Doctor R. R. Buss, Secretary, care of Electrical Engineering Department, Northwestern University, Evanston, Ill.

THURSDAY, NOVEMBER 4

9:00 a.m. Registration

Edgewater Beach Hotel, Chicago

10:00 a.m. Technical Sessions

1. New Materials

(*a*). Properties of CbN at Radio Frequencies, **J. V. Lebacqz, Donald H. Andrews,** Johns Hopkins University

(*b*). Development and Properties of Some Ceramic Dielectrics, **G. R. Shelton, E. N. Bunting, A. S. Creamer,** National Bureau of Standards

(*c*). The Transistor—Its Properties and Characteristics, **Walter H. Brattain,** Bell Telephone Laboratories

2. Sound Measurement—Recording

(*a*). Application of Miniature-Circuit Techniques to the Sound Level Meter, **H. H. Scott,** Hermon Hosmer Scott, Inc.

(*b*). An Evaluation of the Application of New and Old Techniques to the Improvement of Magnetic Recording Systems, **Lynn C. Holmes,** Stromberg-Carlson Company

(*c*). Magnetic Records for Home Entertainment, **Marvin Camras,** Armour Research Foundation of Illinois Institute of Technology

3. Servomechanisms

(*a*). Electronic Circuits for Control of Clutch-Type Servomechanisms, **F. E. Edwards, Jr.,** Buehler and Company

(*b*). Signal Generators for Servo System Measurements, **Charles F. White,** Naval Research Laboratory

(*c*). Evaluating Servomechanisms Performance, **George M. Attura,** Servomechanisms, Inc.

12:15 p.m. Luncheon Meeting

Speaker: Doctor Anton J. Carlson, professor emeritus, department of physiology, University of Chicago; "Science, Industry, and the Future of Man"

2:00 p.m. Technical Sessions

4. Communications

(*a*). Corona Interference with Radio Reception in Aircraft, **M. M. Newman,** Lightning and Transients Research Institute

(*b*). The Effect of Air Speed Upon Precipitation Charging of an Airplane, **Homer J. Dana,** Washington State College

(*c*). Extraction of Weak Signals from Noise by Integration, **Harry Stockman,** Cambridge Field Station

(*d*). Optimum Selectivity in Superregenerators, **Donald Richman,** Hazeltine Electronics Corporation

(*e*). Terminal Equipment for Pulse-Time Multiplex, **A. M. Levine, D. D. Grieg,** Federal Telecommunication Laboratories, Inc.

5. Electronic Instrumentation—I

(*a*). A Square-Law Power-Level Recorder, **W. R. Clarke, A. J. Williams, Jr.,** Leeds and Northrup; **W. R. Turner,** Naval Ordnance Laboratory

(*b*). The Development of a High-Speed Recording Anemometer, **John M. Cage,** Purdue University

(*c*). A Precision Electronic pH Control, **J. E. Breeze,** National Research Council, Canada

(*d*). Electronic Methods for Measurement of Pressure and Displacement, **A. Crossley, D. L. Elam,** Electro Products Laboratories, Inc.

(*e*). Application of a D-C Negative Feedback Amplifier to Compensate for the Thermal Lag of a Hot-Wire Anemometer, **Philip G. Hubbard,** State University of Iowa

6. New Tube Developments

(*a*). Alkali-Metal Alloys for Cathodes of Power Electronic Tubes, **J. A. M. Lyon,** Northwestern University; **C. E. Williams,** Standard Oil Company of Indiana

(*b*). Mass Production Techniques for Television Kinescopes, **D. Y. Smith,** Radio Corporaton of America

(*c*). The Surge Testing of High Vacuum Tubes, **H. J. Dailey,** Westinghouse Electric Corporation

(*d*). A New Subminiature Electrometer Tube, **H. F. Starke,** Raytheon Manufacturing Company

(*e*). Design Considerations for Dual Control Grid Pentode, **Roger W. Slinkman,** Sylvania Electric Products, Inc.

7:00 p.m. Banquet

Marine Dining Room

Edgewater Beach floor show and dancing (women cordially invited; informal)

FRIDAY, NOVEMBER 5

9:00 a.m. Technical Sessions

7. Microwaves

(*a*). The Dyotron Tube as a Very-High-Frequency Oscillator, **R. A. Dehn,** General Electric Company

(*b*). A New Type of Slotted Line Section, **W. Bruce Wholey, W. Noel Eldred,** Hewlett-Packard Company

(*c*). Microwave Slotted Sections, **Stanley A. Johnson,** Polytechnic Research and Development Company

(*d*). Tunable Waveguide Cavity Resonators for Broadband Operation of Reflex Klystrons, **W. W. Harman,** Stanford University

(*e*). A Periodic Waveguide Traveling Wave Amplifier for Medium Powers at Microwaves, **G. C. Dewey,** Federal Telecommunication Laboratories, Inc.

8. Analysis Aids—Computers

(*a*). Root-Solver for Tenth Degree Algebraic Equations, **G. H. Singer, Jr., J. F. Calvert,** Northwestern University

(*b*). Analysis of Rototrol Voltage Regulators by Electrical Analogy, **James T. Carleton,** Westinghouse Electric Corporation

(*c*). A Polar Vector Indicator, **A. H. Waynick, P. G. Sulzer, E. A. Walker,** Pennsylvania State College

(*d*). Automatic Number Storage System, **T. Kite Sharples,** Technitrol Engineering Company, Inc.

(*e*). Design and Operation of the IBM Selective Sequence Electronic Calculator, **Robert Rex Seeber, Jr.,** International Business Machines Corp.

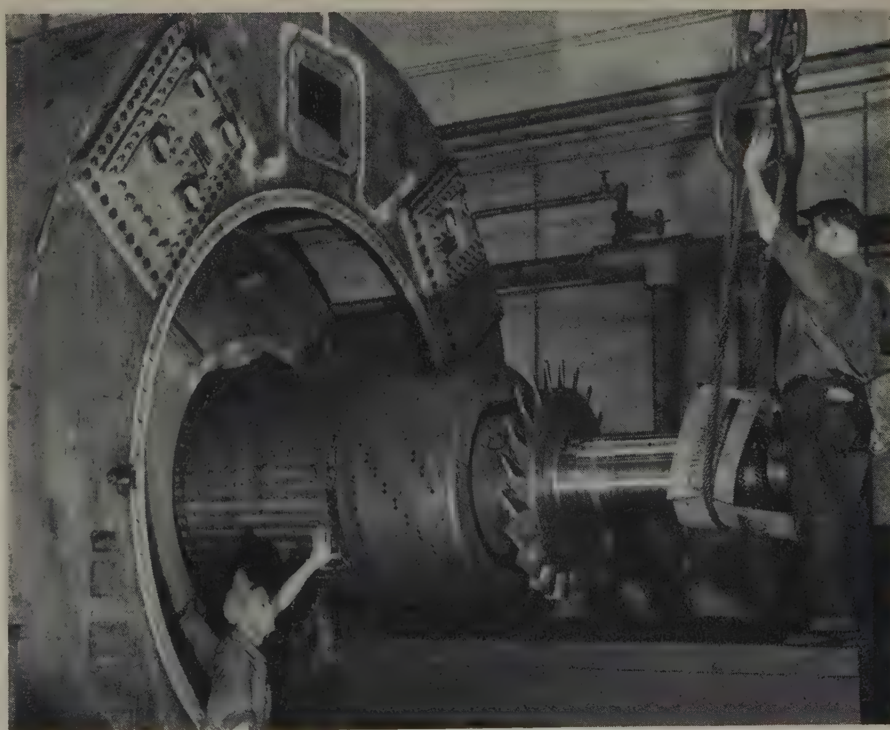
9. Industrial Applications

(*a*). Precision Photoelectric Control of High-Temperature Furnaces, **F. C. Todd,** Battelle Memorial Institute

(*b*). The Application of Radar Techniques to a System for High-Speed X-Ray Movies, **D. Dickson, C. Zavales, L. F. Ehrke,** Westinghouse Electric Corporation

(*c*). CRT Applications in Photography and Optics,

Buffalo to Get 277-Ton Generator



A 277-ton hydrogen-cooled Westinghouse generator, for the Buffalo, N. Y., area, rated at 100,000 kilovolt-amperes, will generate the equivalent of 134,000 horsepower

Carl Berkley, Rudolf Feldt, Allen B. DuMont Laboratories

(*d*). A 500–50,000-Volt Regulated Power Supply, **Roy E. Anderson**, General Electric Company

(*e*). The Fairchild Electronic Half-tone Engraver, **John Boyajean**, Fairchild Camera and Instrument Corporation

12:15 p.m. Luncheon Meeting

Speaker: Donald J. Fink, editor-in-chief, *Electronics* magazine; "The Decline and Fall of the Free Electron"

2:00 p.m. Technical Sessions

10. Television

(*a*). The Locked Oscillator in Television Reception, **Kurt Schlesinger**, Motorola, Inc.

(*b*). Master Television Antenna and Signal Distribution Systems for Large Buildings, **R. D. Duncan, Jr.**, Radio Corporation of America

(*c*). Development of a Large Metal Kinescope for Television, **J. Kelar, H. P. Steier, C. T. Lattimer, R. D. Faulkner**, Radio Corporation of America

(*d*). Large Screen Television, **R. V. Little, Jr.**, Radio Corporation of America

11. Management of Research

(*a*). Organization of Research, **C. C. Furnas**, Cornell Aeronautical Laboratory

(*b*). Development of Physical Facilities for Research, **R. B. Dittmar**, Los Alamos Scientific Laboratory

(*c*). Personnel Administration in Research and Development Organization, **C. E. Barthel, Jr.**, Armour Research Foundation of Illinois Institute of Technology

(*d*). Information Exchange as a Management Tool in a Large Research Organization, **Allen H. Schooley**, United States Naval Research Laboratory

(*e*). Research Ideas Go to Market, **Waldo H. Kliever**, Minneapolis-Honeywell Regulator Company

12. Electronic Circuits

(*a*). Response of an Amplifier to a Signal Varying Linearly in Frequency, **W. H. Hamilton**, Westinghouse Electric Corporation

(*b*). An Extremely Wide Range Electronically Deviable Oscillator, **Millard E. Ames**, Philco Corporation

(*c*). An Improved Regenerative Frequency Standard Application, **F. E. Wyman**, Naval Research Laboratory

(*d*). Design of a Wide-Band Frequency Discriminator Circuit, **Vincent C. Rideout**, University of Wisconsin

(*e*). Circuit Design for Reduction of Hum, **Arthur F. Dickerson**, General Electric Company

8:00 p.m. Demonstration—Ballroom

Large Screen Television, **R. V. Little, Jr.**, Radio Corporation of America. This is a repeat performance of the demonstration in paper 10(*d*) for those unable to attend the earlier demonstration

SATURDAY, NOVEMBER 6

9:00 a.m. Technical Sessions

13. Magnetic Amplifiers

(*a*). An Analysis of Magnetic Amplifiers with Feedback, **D. W. VerPlanck, M. Fishman**, Carnegie Institute of Technology

(*b*), Influence of Core Material on Magnetic Amplifier Design, **A. O. Black, Jr.**, United States Naval Ordnance Laboratory

(*c*). An Analysis of Interlinked Electric and Magnetic Networks With Application to Magnetic Amplifiers, **D. W. VerPlanck, M. Fishman**, Carnegie Institute of Technology

14. Electronic Instrumentation—II

(*a*). An Electronic Power Factor Meter, **H. B. Kurtz, Paul O. Erickson**, State University of Iowa

(*b*). A Cathode-Ray Oscillograph with 100-Megacycle Bandwidth, **M. M. Newman**, Lighting and Transients Research Institute; **P. S. Christaldi, R. P. Featherstone**, Allen B. DuMont Laboratories, Inc.

(*c*). Absolute Accuracy—Primary Frequency Standard, **Harry R. Meahl**, General Electric Company

(*d*). A Low Distortion AM Signal Generator, **E. S. Sampson**, General Electric Company

(*e*). An Electron Tube for Viewing Magnetic Fields, **S. G. Lutz, S. J. Tetenbaum**, New York University

15. Antennas

(*a*). Radio Direction Finding System Analyzer, **E. C. Jordan, J. J. Myers**, University of Illinois

(*b*). Open-Ended Waveguide Radiators, **R. E. Beam, M. M. Astrahan, H. F. Mathis**, Northwestern University

(*c*). Measurement of Phase of Radiation Around Antennas, **John N. Hines, Charles H. Boehnker**, Ohio State University Research Foundation

(*d*). The Measurement of Antenna Impedance Using a Receiving Antenna, **Donald G. Wilson**, University of Kansas

(*e*). A High-Gain Cloverleaf Antenna, **P. H. Smith**, Bell Telephone Laboratories, Inc.

G. R. Henninger Named Head of IES Publications

The Illuminating Engineering Society has announced the appointment of G. Ross Henninger, former editor of *ELECTRICAL ENGINEERING*, as its director of publications, effective October 1, 1948. This is a further step in the society's long-range planned program of development and extension of services to the lighting industry in general and to its members in particular. To facilitate the development and operation of its expanded activities program, the society has organized its headquarters staff into three correlated departments: general administration under Executive Secretary A. Dexter Hinckley; technical-committee and research activities under Technical Director C. L. Crouch; and publications activities under Mr. Henninger.

The Illuminating Engineering Society was founded in 1906 for the study, evaluation, and discussion of the numerous phases of the art and science of illumination and "for the advancement and dissemination of knowledge relating thereto." The technical and developmental phases of this work currently are being carried on actively throughout the lighting industry through the medium of 80 technical committees. The society has grown steadily especially strongly in recent years, and now has some 6,500 members who participate in its activities through its technical and administrative committees and through some 40 local sections and chapters throughout the United States and Canada.

With its January 1949 issue, the society's monthly journal, *Illuminating Engineering*, will be enlarged from its traditional 6-by-9-inch page size to the nominal 9-by-12-inch size class of the other major engineering society publications and professional and trade journals. Another precedent will be set aside with the opening of the pages of this monthly journal to advertising pertinent to all phases of the lighting industry.

A broader range of text matter is scheduled to be included in *Illuminating Engineering* with more attention given to the field of lighting applications and to the solution of the practical problems met with in that field. Significant news of the lighting industry will be consistently reflected and interpretively discussed. It is contemplated that the society's long-established series of Lighting Data Sheets will be incorporated as one of the feature services of the magazine. Also, this monthly journal will continue to serve as the society's *Transactions*, carrying approved technical conference papers and related discussion as heretofore, although these will be presented in more attractive physical form making more effective use of illustrations.

In addition to the technical and application information, it also is part of the objective of the society's enlarged program that the advertising content progressively will furnish additional significant and useful data pertinent to lighting equpment and to related materials, supplies, and services. These and other scheduled developments have been brought about to meet the expanding interests and needs of the society's steadily growing membership. Other members of the IES family of publications include the progressive series of American Standard Lighting Practices and various Recommended Practices and various reports covering desirable standards of quality and quantity for office, school, domestic, commercial, and industrial illumination; also, the IES Lighting Handbook which first was issued in 1947, reprinted in 1948, and currently planned for revision and reissue about 1950.

As its new director of publications, Mr. Henninger will correlate these and other publications activities, and also will serve as editor of *Illuminating Engineering*, responsible for both its business and editorial development. Before coming to the Illuminating Engineering Society's staff, Mr. Henninger was for 18 years a member of the headquarters staff of the AIEE in New York, N. Y., from 1930 to 1933 as associate editor and since 1933 as editor of *ELECTRICAL ENGINEERING* (see Personal Notes section, page 1014).

UN Conservation Conference to Be Held in United States

United Nations scientific conference on the conservation and utilization of resources is scheduled to be held in the United States in May–June 1949 under the authority of the Economic and Social Council of the United Nations. This conference represents a new approach to one of the objectives of the United Nations, the promotion of economic development and higher standards of living throughout the world, by a free exchange of ideas and experience on the conservation and utilization of resources.

In its plenary meetings, comprising approximately half of the program, the conference will examine the contribution of improved techniques to the alleviation of shortages of fuel and energy, mineral resources, and food and forest products. A series of plenary meetings will be devoted to questions of particular importance to underdeveloped countries.

Specific problems and techniques will be placed on the agenda of specialized section meetings which form the other half of the program. In these meetings, specialists will discuss conference papers on subjects such as forests, water, fisheries and wildlife, fuel and energy, power, mineral resources; and the interrelated group of subjects included under soils, crops, grazing, and livestock resources.

The conference will be scientific rather than policy-making. Technical developments will be selected for discussion according to the importance of their practical contribution, actual and potential, to economic development and will be treated so as to interest the economist as well as scientist, administrator, and engineer. Conference papers submitted by experts as well as summary records of discussions will be published after the conference, and it is expected that they will be a continuing and important contribution of the United Nations to better conservation and utilization of resources.

Huge Generator Cast in Two Parts

Because of its tremendous size, and to facilitate manufacture, it was necessary to fabricate, anneal, and machine the frame of this 15,000-kw turbogenerator in two sections. Welders in the General Electric turbine shop at Schenectady, N. Y., are shown here joining the two 15-foot sections prior to shipping it to its destination. A special 8-axle railroad car will carry the assembled armature's estimated 400,000 pounds

ORC Offers Officer Rank to Qualified Experts

Civilians, possessing either professional or technical qualifications which are critically essential and immediately adaptable to the needs of the Army, may get direct appointments in the Officers' Reserve Corps according to a new policy outlined by the Department of the Army. Commissioning of specialists is intended to provide a continuing source of officers experienced in fields in which it is not feasible or economical for the Army to give training. The establishment of standards under the new policy now opens the way for those who previously applied for direct commission in specialist fields to resubmit their applications.

Such specialties as electrical engineering, artwork, dietetics, dramatics, laundry and dry cleaning, various other branches of engineering, motion picture production, printing, and submarine diving, are included in a list of 75 varied fields. Men commissioned under the program subsequently will gain a knowledge of military procedures by being required to meet, within a reasonable length of time, the minimum military-training requirements established to maintain a commission in the grade and section in which appointed, and in their mobilization assignment.

In addition to specific schooling or experience in any of the foregoing fields, applicants for direct appointments must be at least 21 years old, citizens of the United States by birth or naturalization, must have an Army intelligence score of 110 or higher, physically qualified, with some waivers, and at least a bachelor's degree. Some special fields require only a high school education or equivalent preparatory school education.

Age maximums and educational or experience minimums are: second lieutenants, 30 years with 4 years college or experience; first lieutenants, 33 years with 7 years college or experience; captains, 37 years with at least 11 years college or experience; majors, 45 years, with at least 16 years college or experience; lieutenant colonels, 51 years, with at least 21 years college or experience; and colonels, 55 years, with at least 26 years college or experience. All correspondence should be directed to the headquarters of the Army area nearest to the applicant's home.

UN to Celebrate Anniversary. The United Nations General Assembly has set October 24, 1948, as "United Nations Day," and asks that all citizens of all UN participating nations use that day to learn what the United Nations is and does. Secretary of State George C. Marshall has appointed a National Citizens Committee to promote observance in this country by organizing local programs in every state and community in the United States.

Stanford Research Appoints New Heads. The expanding Stanford Research Institute, Palo Alto, Calif., announces the appointment of Ralph A. Krause as director of research, and Doctor Abe M. Zarem as manager of the new Los Angeles division of the institute. Mr. Krause, former assistant to the president of the Raytheon Manufacturing Company, Waltham, Mass., was a pioneer researcher in electronics, radio, and nuclear science. He served as assistant director of the Massachusetts Institute of Technology's Laboratory of nuclear science and engineering which he helped organize, and is a consultant to both the research and development board of the department of national defense and the Brookhaven National laboratory at Upton, N. Y. Doctor Zarem was chief of the electrical section of the physical research division at the United States Naval Ordnance Test Station at Pasadena, Calif., prior to joining the institute's staff. He is an authority on ultrahigh-speed photography and measurement techniques and is the inventor of the Zarem camera. Doctor Zarem's division will co-ordinate its activities with those of the main offices of the institute in the current research program in such fields as development of radar and television equipment, electronics and television communication problems, smog control, high-speed photography, and petroleum chemistry.

Power Plant Innovations to Be Shown at Exposition

A long list of innovations designed to improve the performance of power plants is assured for the 18th National Exposition of Power and Mechanical Engineering, scheduled at Grand Central Palace, New York, N. Y., November 29 to December 4, 1948. This is made known through the filing of plans for their exhibits by a substantial number of manufacturers who already have contracted for space.

Among the developments which visitors at the exposition will see is a 2,000-horsepower fluid drive capable of pumping a million pounds of water an hour into a high-pressure boiler, and a new type of steam turbine centrifugal marine boiler feed pump. An improved method of removing tramp iron from coal will be demonstrated; while a number of engineering improvements have improved the performance of a well-known spreader stoker. These include an electro-hydraulic drive, alternate pusher coal feed, and an "incremental" control valve for feed regulation.

With smoke prevention coming into critical regard in many communities, there will be considerable interest in a new "Robot-Eye" combustion control that automatically regulates the fuel-air ratio for smaller and medium sized heavy oil-fired boilers, effecting an efficiency that is said to be comparable with larger plants, yet without the danger of forming smoke. With a thought for the exigencies of the fuel situation there also will be the exhibitor of a package-type steam generator who features provision for a quick changeover of the "automatic fuels" light and heavy oil and gas.

Other exhibits will include the extension of the packaged equipment idea, especially adaptable to the needs of smaller industrial

plants to compressor units, said to be of special interest to food packers and laundries; also a display of "the only 2-speed portable electric blower manufactured;" as well as a brand new portable all-electric steam cleaner, especially designed for economical plant maintenance. A newly improved condenser will be offered by a well-known specialist in industrial air conditioning; while a new application for synchronous electric timers will make its bow in a device that provides automatically for the periodic cleaning of electrostatic air filters. Of scientific as well as economic significance is a recently developed method for sterilizing water without the aid of either heat or chemicals and without imparting an unpleasant flavor or odor. In the long line of new instruments already assured for the exposition are a new pyrometer; a multiple recorder which traces four lines on a chart simultaneously; and several newly developed methods of automatic pH control.

Magnetic Tape Standards Ready for Approval

Early adoption of standards for magnetic recording was foreseen by the National Association of Broadcasters' recording and reproducing standards committee, with announcement of a final project group proposal of three recording speeds for magnetic tape. The proposal, formulated by a project group of the NAB committee, will be submitted to the full committee, whose chairman is Royal V. Howard (M '46) NAB engineering department director.

The group's proposal involves adoption of a primary standard magnetic tape speed of 15 inches per second, a secondary standard of 7.5 inches per second, and a supplemental standard of 30 inches per second, it was announced. The 7.5-inch speed corresponds to the Radio Manufacturers Association's recently proposed velocity for home recordings. The 30-inch supplemental speed will correspond to the speed of various American machines now in production and also to the European standard 77-millimeter (30.318 inches) established by the German magnetophone. The committee agreed that the 30-inch speed normally would be used only for processing and other specialized work and generally would have little employment in regular routine.

The group unanimously agreed that the primary speed of 15 inches would meet the NAB frequency-response characteristics minimum specifications from 50 to 15,000 cycles. The group pointed out that with the present state of the art this response was difficult to obtain, but that with advancing knowledge this speed should provide sufficient margin to justify its adoption. The proposed secondary standard of 7.5 inches would meet the NAB all-industry engineering planning group's specifications for a frequency response of 50 to 7,500 cycles per second. The 30-inch supplemental speed would meet all wide-range standards.

The magnetic recording group discussed the British Broadcasting Corporation's proposed standard of 77 millimeters and decided that the American standard 30-inch speed did not constitute a serious differential and therefore would permit the interchange of programs. The committee concluded that the small area of differences between the other American and Continental proposals could be resolved. In other standards the committee previously had recommended the width of the tape should be 0.250 plus 0 minus 0.006 inch in width and, while not setting a minimum thickness, the tape specifications were not to exceed 0.0022 inch. The committee also agreed that the minimum playing time per reel should be 33 minutes. Noise level was set at at least 40 decibels below peak signal level. Zero decibel level was set at 2 per cent distortion.

It is expected that these magnetic recording standards will be ready for submission to the NAB board of directors for final adoption at the regularly scheduled November meeting.

OTS Releases New Reports. The Office of Technical Services of the Department of Commerce has authorized the release of the following three items: First, a 29-page bibliography which includes 425 American and 98 British reports on atomic energy that have been declassified and released through February 1948. Mimeographed copies are available for 75 cents. Second, is the final report on American wartime research on point contact rectifiers made from germanium tin compositions for use as second detectors and d-c restorers in wide band radar receivers. Photostatic copies of the report sell for $7 and microfilm copies are $2.50. Last is the fourth foreign patent protection program list. The list contains 61 cases never brought to public attention before, plus a collection of patent applications of American discoveries in radar and ultrahigh-frequency electronics. This list is available from the department. Orders for all reports and lists should be addressed to the Office of Technical Services, Department of Commerce, Washington 25, D. C., and should be accompanied by check or money order for the amount specified, payable to the Treasurer of the United States.

Hodge of Stevens Institute Dies. Doctor Percy Hodge, professor of physics at Stevens Institute of Technology, Hoboken, N. J., for 27 years and professor-emeritus since 1938, died at the age of 78, August 4, 1948, following a long illness. Born at Hudson, Ohio, he received his bachelor of arts degree from Western Reserve University in 1892; his bachelor of science degree from the Case School of Applied Science in 1894; and his doctor of philosophy degree from Cornell University in 1908. In 1910, he became an assistant professor at Columbia University, and one year later joined the faculty at Stevens as head of the physics department. He was a member of both the Physical and Optical Societies.

ESPS Appoints New Chicago Manager. Joseph R. Decker, former chief of training facilities with the Veterans Administration, has been appointed manager of the Chicago office of the Engineering Societies Personnel Service, Inc. He will succeed Thomas Wilson who is retiring after 16 years.

GE Develops Magnetron Tube. A new high-power magnetron tube, with a continuous wave output of 50,000 watts at a frequency of one billion cycles per second, has been developed for the United States Signal Corps by the General Electric research laboratory. This tube's output represents the greatest continuous wave power ever produced at the billion-cycle frequency according to General Electric scientists. The tube itself is water-cooled but, unlike most conventional vacuum tubes which require an external source of electric power for cathode heating, it obtains the necessary heat by secondary emission within the tube itself created by the high velocity of the emitted electrons.

EDUCATION • • •

Lincoln Foundation Announces 1948–49 Scholarship Program

The trustees of The James F. Lincoln Arc Welding Foundation have announced September 15, 1948, to April 1, 1949, as the period for submitting entries in its annual engineering undergraduate award and scholarship program. The current competition is the second in a 10-year series of programs which offer to engineering undergraduates (including agricultural engineers) the opportunity to compete in the preparation of papers on various phases of welding for monetary awards as well as scholastic and industry recognition.

Students' papers may fall in one or more of the following categories:

1. Design.
2. Maintenance and repair.
3. Welding fabrication.
4. Research and development.

Resident engineering undergraduate students registered in any school, college, or university in the United States, which offers a curriculum in any branch of engineering or architecture leading to a degree and cadets registered in the United States Military Academy, United States Naval Academy, and Coast Guard Academy are eligible to submit papers in this award program.

The program contains two interdependent plans: the award plan and the scholarship plan. Under the award plan, engineering students of various engineering schools and colleges will submit papers on arc welding applications or arc welding technology. There will be 77 awards totaling $5,000, and seven scholarships totaling $1,750. Under the scholarship plan the institutions in which the three top awards are made to students will receive amounts of money equal, respectively, to those awards. These amounts are to be used for the purpose of scholarships in the departments in which the award students are registered.

The rules of the program were reviewed and approved by the deans of engineering of 14 prominent engineering colleges and may be obtained by writing The James F. Lincoln Arc Welding Foundation, Cleveland 1, Ohio.

Airborne Laboratory Offers Fellowships. Two fellowships have been established by the Airborne Instrument Laboratory, Inc.,

Mineola, N. Y., to aid worthy young men to obtain advanced degrees in the field of communications and electronics. To be known as the Airborne Instrument Laboratory Fellowships, one is for $1,000 plus tuition at Stanford University, Palo Alto, Calif.; the other, for $1,200 for a single man or $1,800 for a married man, plus tuition, is at the Massachusetts Institute of Technology. Recipients will be selected by the electrical engineering department staff of each school, and scholarships will be awarded on the basis of high scholarship, plus a consideration of the applicant's personality and need for financial assistance. The donor has expressed a preference that the awards be made to men interested in broad-band high-frequency systems, including filters, transmission lines, and vacuum-tube generators or amplifiers.

L. G. Miller Named Engineering Dean. Beginning with the current semester, Professor Lorin G. Miller, former head of the department of mechanical engineering, will assume the duties of dean of engineering at the Michigan State College, East Lansing, Mich. He succeeds Dean Henry B. Dirke who has retired. Professor Miller, a national authority in the field of heating and ventilation, is a graduate of Des Moines University, Iowa, and the Massachusetts Institute of Technology and has been on the engineering faculty at Michigan State College since 1929. He is a member of the governing council and the executive committee of the research board of the American Society of Heating and Ventilating Engineers and is a past president of that society's West Michigan chapter. Nationally known as a speaker on engineering topics, Professor Miller is also the author of numerous journal and magazine articles.

OTHER SOCIETIES

American Society for Metals Asks for Award Nominees

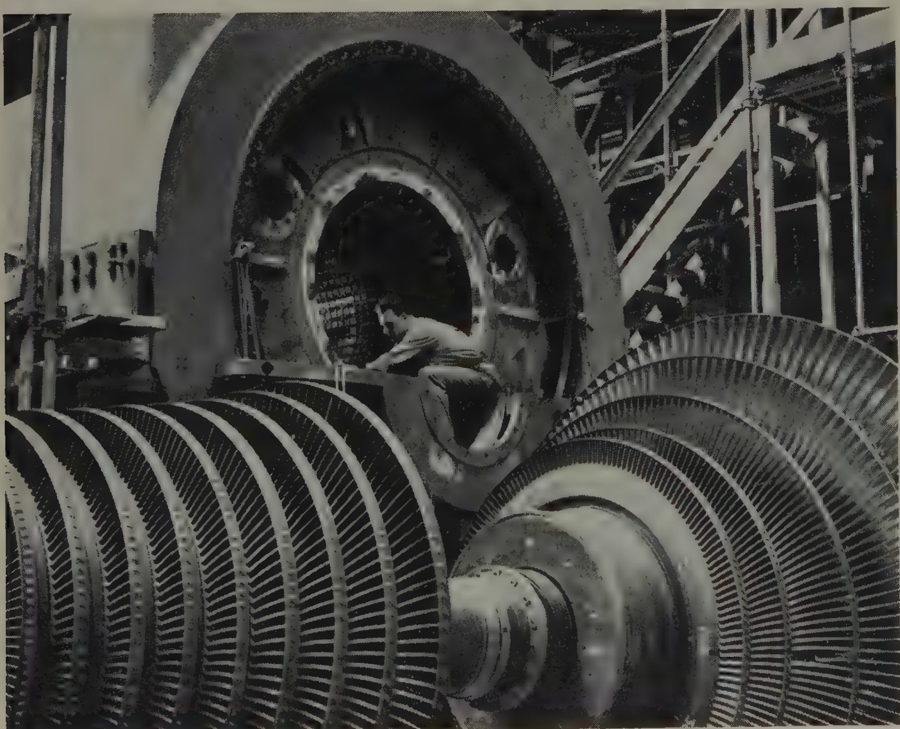
The American Society for Metals will make distinguished service awards to leaders in the field of engineering alloy steels at the National Metal Congress and Exposition to be held October 25–29, 1948, in Philadelphia, Pa. This congress and exposition will celebrate the 75th anniversary of the first engineering use of an alloy steel.

Members of all organizations and industries in alloy steel engineering and any related fields are asked to submit the names of any living individuals who justifiably can be honored by such an award for their contributions in this phase of engineering.

An awards committee, headed by J. M. Schlendorf, vice-president of the Republic Steel Corporation, will consider all nominations of individuals from all branches of this field. Categories of eligibility include research in metallurgical processes, development of research and inspection techniques, discoverers of alloy steels themselves, notable men in organization and promotion, and men responsible for notable applications in consuming industries, such as transportation, power, agriculture, chemical, petroleum, machine, and ordnance industries.

Nominations should be mailed to: J. M. Schlendorf, Chairman, Distinguished Service Awards Committee, care of Republic Steel Corporation, Republic Building, Cleveland 1, Ohio.

Turbogenerator Set Ready for Testing



The 100,000-kw turbogenerator set being made for the Public Service Electric and Gas Company of New Jersey is shown being assembled for test at the General Electric turbine shop at Schenectady, N. Y. Designed for operating steam conditions of 1,500 pounds gauge and 1,050 degrees Fahrenheit, the complete unit will be approximately 85 feet long. Top speed of the last-stage wheels of the 35-foot-long 70,000-pound 23-stage turbine rotor is about 1,390 feet per second, well above the speed of sound. The stator frame housing the generator rotor weighs 75,200 pounds

Future Meetings of Other Societies

American Chemical Society. Fifth National Chemical Exposition and National Industrial Chemical Conference, October 12–16, 1948, Chicago, Ill.

American Institute of Chemical Engineers. November 7–10, 1948, Hotel Pennsylvania, New York, N. Y.

American Mathematical Society. November 3–5, 1948, Birmingham, Ala.

American Oil Chemist's Society. Fall meeting, November 15–17, 1948, Pennsylvania Hotel, New York, N. Y.

American Society of Civil Engineers. Fall meeting, October 13–15, 1948, Boston, Mass.

American Society of Mechanical Engineers. November 28–December 3, 1948, Hotels Pennsylvania and New Yorker, New York, N. Y.

American Society for Metals. October 23–29, 1948, Benjamin Franklin Hotel, Philadelphia, Pa.

American Society of Refrigerating Engineers. 44th annual meeting, December 5–8, 1948, Washington, D. C.

American Welding Society. October 25–29, 1948, Bellevue-Stratford Hotel, Philadelphia, Pa.

Association of Iron and Steel Engineers. Iron and Steel Exposition, September 28–October 1, 1948, Cleveland, Ohio.

Electrochemical Society. October 13–16, 1948, Hotel Pennsylvania, New York, N. Y.

FM Association. Annual convention, October 11–12, 1948, Sheraton Hotel, Chicago, Ill.

Institute of Radio Engineers. Pacific Coast convention, September 30–October 2, 1948, Los Angeles, Calif.

National Electrical Manufacturers Association. November 8–13, 1948, Atlantic City, N. J.

National Electronics Conference. November 4–6, 1948, Edgewater Beach Hotel, Chicago, Ill.

National Exposition of Power and Mechanical Engineering. November 29–December 4, 1948, Grand Central Palace, New York, N. Y.

National Plastic Exposition. September 27–October 2, 1948, Grand Central Palace, New York, N. Y.

National Research Council's Conference on Electrical Insulation. October 27–29, 1948, at the National Bureau of Standards, Washington, D. C.

National Safety Congress. October 18–22, 1948, Chicago, Ill.

Porcelain Enamel Institute. Tenth annual forum, October 13–15, 1948, Urbana, Ill.

Prime Movers Committee of the Pennsylvania Electric Association. October 28–29, 1948, Carver House, Warren, Pa.

Society of Motion Picture Engineers. October 25–29, 1948, Hotel Statler, Washington, D. C.

Society of Naval Architects and Marine Engineers. November 10–13, 1948, Waldorf-Astoria Hotel, New York, N. Y.

Society for Non-Destructive Testing. October 27–28, 1948, Benjamin Franklin Hotel, Philadelphia, Pa.

Industrial Chemical Parley to Be Revived at National Exhibit

The National Industrial Chemical Conference will be revived after having been omitted for two years when the Chicago section of the American Chemical Society holds its fifth National Chemical Exposition October 12–16, 1948, at the Coliseum in Chicago, Ill.

Latest developments and applications in industrial chemistry will be exhibited and 21 technical papers, reporting on recent findings in chemistry as applied to general industry, are scheduled for discussion.

Sessions will be devoted to the following categories: chemical market development, chemistry in general industry, hazards from chemicals, industrial research management, pilot plant use, and aspects of an educational program for high school students. Added feature will be a technical bureau set up as a help to small businessmen and manufacturers seeking knowledge of how chemistry can be applied to their production plans. Show headquarters are at 1505 South Wabash Avenue, Chicago 5, Ill.

Third Midwest ASQC Meeting. The eight midwest sections of the American Society for Quality Control will hold their Third Midwest Quality Control Conference November 4 and 5, 1948, at the Hotel Sherman, Chicago, Ill. Luncheon sessions, at which two top-ranking business executives will talk on the benefits of statistical quality control applications in their plants, will highlight the program. Cost of the 2-day meeting, including luncheon and sessions, is $15. Further details are obtainable from the Third Midwest Quality Control Conference, Post Office Box 1097, Chicago, Ill.

New Research Society Formed. A new national scientific society called the Scientific Research Society of America (SRSA), with headquarters at Yale University, New Haven, Conn., promises to open up a new era of co-operation between the campus and the factory. This new group is an offspring of Sigma Xi, national scientific honor society. Several reasons for SRSA's formation include: a closer association between university scientist and his fellow in the industrial and government laboratory; to keep these experts abreast of latest advances in their own, related, and unrelated sciences; to give them the recognition "they have so justly earned in later life." Plans have been made to organize clubs in industrial and government laboratories throughout the United States.

Ampere Society Seeks Members. The Society of the Friends of Ampere is seeking to expand its American membership to enable it to continue its collections and work, and to maintain the Ampere Museum at Poleymieux, France. The society was formed in 1930 to perpetuate the work and name of Andre-Marie Ampere, founder of the science of electrodynamics. "Ordinary" members fees are $1 per year or $10 for life membership; "subscribing" members fees are $5 per year or $50 for life membership. All correspondence should be sent to the American delegate, David Landau, 353 Fort Washington Avenue, New York 33, N. Y.

ASTE to Have Own Building. Construction of a building to house the activities and central office of the American Society of Tool Engineers is almost completed, and the society will begin occupancy November 1, 1948. Financing of the project was done by a special investment bond issue sold only to ASTE chapters and members. The building being erected is on a 224 by 100 foot tract on Puritan Avenue between Monto Vista and Manor Avenue in northwest Detroit, Mich., and will have 12,000 square feet of floor space on a single floor, in comparison with the 3,500 square feet now being used. Specifications include an oil-fired warm air heating system, air conditioning plant, and a combination garage and loading dock.

Safety Council to Convene. Nearly 10,000 safety-minded persons are expected from all corners of the United States and other parts of the world at the 36th annual National Safety Council convention, Chicago, Ill., October 18–22, 1948. Up-to-the-minute problems will be presented to the aircraft manufacturing section when it hears talks on "Maintenance and Testing of Jet Aircraft Engines," "Handling of Aircraft Rocket and Guided Missiles," and "Supersonic Sickness and Noise Abatement." A nonveteran topic will come before the veterans of safety meeting when Milton S. Aronstam, of the United States Atomic Energy Commission, speaks on "Problems Involved in Atomic Energy Research." "Nucleonics—Its Threats and Promises" is a subject to be presented to the American Society of Safety Engineers. Sessions on industrial safety will be held at the Stevens, Congress, and Morrison Hotels, with the industrial exposition and motion pictures at the Stevens Hotel. Commercial vehicle and transit activities will be centered in the Morrison Hotel, as will the school and college sessions. Traffic, farm, home, and women's sessions will be in the Sherman Hotel, where the public safety exposition and film showings will be held. A labor-management session again will bring together representatives of the American Federation of Labor, the Committee of Industrial Organization, and industrial management in a discussion of safety responsibilities and methods.

LETTERS TO THE EDITOR

INSTITUTE members and subscribers are invited to contribute to these columns expressions of opinion dealing with published articles, technical papers, or other subjects of general professional interest. While endeavoring to publish as many letters as possible, Electrical Engineering reserves the right to publish them in whole or in part or to reject them entirely. Statements in letters are expressly understood to be made by the writers. Publication here in no wise constitutes endorsement or recognition by the AIEE. All letters submitted for publication should be typewritten, double-spaced, not carbon copies. Any illustrations should be submitted in duplicate, one copy an inked drawing without lettering, the other lettered. Captions should be supplied for all illustrations.

Voltage Notation Conventions

To the Editor:

The authors of the article, "Voltage Notation Conventions" (*EE, Jan '48, pp 41–8*) have rendered a real service to the electrical engineering profession and it only can be hoped that their carefully assembled exhibition of the chaotic conditions existing at present concerning the designation of voltages will stir up enough thought and argument to lead finally to the adoption of a uniform practice in this field. Those of us that have been practicing electrical engineering for a good many years usually are able to reconcile the vector diagram of a transformer, for instance, shown by one author with the primary and secondary voltages in phase but the currents 180 degrees out of phase, with that presented by another author, who shows the voltages out of phase and the currents in phase, but to our younger engineers this sort of thing is the source of a good deal of confusion. The recommendation of one particular convention, with the authors of papers and books gradually falling in line, indeed would be a distinguished service which the Institute could render to the profession.

Most of the electrical engineers, instructors, and writers have developed a system of designating voltages either by arrows or by double-subscripts which to them is perfectly clear and entirely logical. As a matter of fact, anyone of the systems described by the authors probably is entirely logical and has certain advantages over its competitors. Now it must be admitted that a man might write a very valuable book on the use of tools and in the introduction state that every time he uses the word "hammer" he means a chisel and every time he uses the word "chisel" he means a pair of pliers. But certainly nobody will deny the desirablity to agree on what a given term means and this is exactly the need as it exists today with regard to the designation of voltages. The committee on basic sciences of the Institute should invite proponents of the various ways of designating voltages to present their viewpoints and reasons why their particular system is preferable and then recommend one system to the profession. That there will be

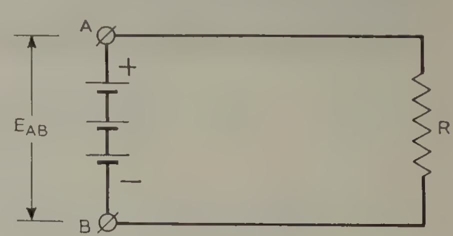


Figure 1

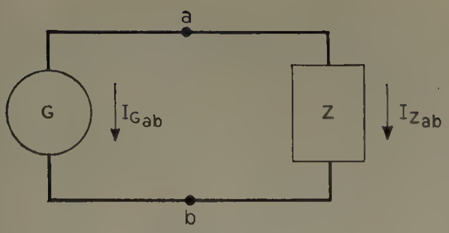


Figure 2

some disappointed people cannot be helped, but any system generally adopted will be superior to the present coexistence of a number of them.

By definition, the voltage between two points is the potential difference between them, and since the potential of a point is defined as the work necessary to move the positive unit of charge from infinity to this point, then the voltage between two points necessarily by definition is the work necessary to move the positive unit of charge from one terminal to the other. As ordinarily we do not associate direction with work, I agree fully with the authors when they suggest that the association of direction with voltage should be discouraged. A point is at a higher potential when it takes more work to transport the positive charge from infinity to it than it does to some other point; similarly Pikes Peak is at a higher level than Denver, because it takes more work to transport one pound from sea level to it, than it does to Denver. But what is the direction between the level difference between Pikes Peak and Denver? Only by bringing in another notion such as, "In which direction will a ball roll between the two points," could direction be associated with this difference in level?

The authors state the simple and indisputable fact that the potential difference between two points is not endowed with some mysterious properties depending on how it is produced. They point out that, given two terminals coming out of an enclosure, there is no measurement which would disclose whether the potential difference between the two points is due to a battery, due to a changing magnetic field passing through a coil due to a charged capacitor or due to a current flowing through a resistance. Why it should be necessary to use two symbols, E and V, is beyond the comprehension of this discusser. If we connect a resistor across a 6-volt storage battery and measure the voltage existing between the two terminals of the battery (which are now at the same time the terminals of the resistor) do we measure the voltage of the battery or the voltage across the resistor? Why should the one be called E, the other V, and why should one be negative and the other be positive?

Consider now a 6-volt storage battery as shown in the accompanying Figure 1, with its terminals marked A and B. A load is shown across the battery but this obviously does not change anything on the polarity of the voltage existing between the two terminals A and B. In the following table are listed the possible interpretations of the double-subscript method of designating the voltage E_{AB} or V_{AB}, and what an adherent to that particular definition would give as the value of the observed voltage.

The table shows ten possibilities but no claim is made that it is complete.

V_{AB} or E_{AB} may be defined as	The potential difference between points A and B, that is, the potential of point A minus the potential of point B	+6
	The potential difference between points B and A, that is, the potential of point B minus the potential of point A	−6
	The potential (or level) of point A with respect to point B. (In other words B is the reference point.)	+6
	The potential (or level) of point B with respect to A. In other words, A is the reference point	−6
	The voltage or potential rise from A to B	−6
	The voltage or potential rise from B to A	+6
	The voltage fall from A to B	+6
	The voltage fall from B to A	−6
	The voltage "acting" from A to B	+6?
	The voltage "acting" from B to A	−6?

Furthermore, for all those who insist that V and E are opposite, in other words that the terminal voltage is always the opposite of some mysterious electromotive force acting on whatever is between these terminals, there exist immediately ten more possibilities. The last two lines in the table may require a little explanation, because the term "acting" is open to argument. One might say that a voltage "acts" from point A to point B if upon connecting points A and B by a resistance, current would flow from A to B. With this definition the plus and minus sign as indicated in the table will result.

The table shows that half of the definitions lead, for the particular case shown in the figure, to a plus sign while the other half leads to a minus sign. This is of course rather reasonable no matter what definition one might pick on. We always can consider either the first or the second one of the subscript as the reference point which will naturally lead to opposite results.

Now we may take a pencil, close our eyes and stab at the table and elect the definition chosen in this manner as the standard. Any one of them, if generally accepted, will be preferable to the necessity of having to deal with all ten of them, depending on whose book or paper we read. Personally, I hope that the pencil will land on a definition which results in a plus value in this particular case, for the same reason that the authors recommend such a choice. Ohm's law is the fundamental law of electric circuits, and it connects the voltage across a resistor with the current flowing through it. Its discoverer was not worrying about double-subscripts but only proclaimed the proportionality between voltage and current, but there can be no harm in attempting to fit the double subscript notation into it without having to change it. Now the authors have shown that there is practically no confusion about the notation I_{AB}. By this is usually meant a current flowing from A to B (although there is of course no reason why one could not define it in the opposite way.) Ohm's law reads:

$$E=I\times R$$

When introducing double-subscript notation into Ohm's law it would evidently be desirable if the sequence of subscripts would be the same on both sides and if both sides of the equation would also retain the positive sign. In other words, when defining E_{AB} it would be desirable to formulate the definition in such a manner that Ohm's law will read:

$$E_{AB}=I_{AB}\times R$$

But if in a resistance with the terminals A and B a current flows from A to B (in other words, I_{AB} is positive) then terminal A must be at a higher potential than terminal B, and the definition for E_{AB} should be made in such a way that it turns out as positive when terminal A is positive with respect to terminal B. This is the same reasoning that the authors use in arriving at their recommendation; there is, however, another argument in favor of this convention. If a single subscript is used to designate the potential of a given point, in other words, if E_A represents the work necessary to move the unit charge from infinity or from any point of zero potential to point A, then it would seem convenient as well as logical to define E_{AB}, as E_A-E_B, retaining the sequence of the subscripts, rather than E_B-E_A. If point A is then at a higher potential than point B (in other words, if it is the positive terminal of the two) E_{AB} will turn out as positive. In my own teaching activities I have used the third definition given in the table because I have endeavored to make my students visualize a voltage as a height or level difference; in agreement with the authors of the present article, the second of the two subscripts will then be the reference point.

The authors ably have pointed out that the only possible objection might arise when this notation is applied to vectordiagrams but when it is once agreed upon that the second subscript is the reference point, then, since the reference point in any vectordiagram is the point around which the vectors rotate no

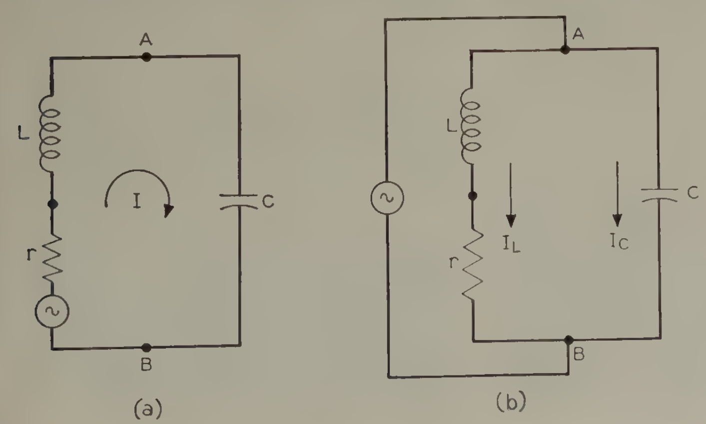


Figure 3

particular mental effort is demanded to associate the second subscript with the origin. The projection of the arrowhead on a vertical line is then the instantaneous potential of the terminal designated by the first subscript with respect to the reference terminal, that is, the second subscript.

When the double-subscript method is used for the designation of currents, the situation is somewhat different. While the voltage between two points is a physical quantity which cannot have more than one value at the same time (at least not when we confine ourselves to scalar fields), there may be any number of current paths between two points, all of them carrying currents of different amounts. As a matter of fact, if there is any path carrying current at all between two points, there must be at least one other path, since at least one return path must be provided for the current in the path under consideration. In Figure 1*A* of the article a simple circuit consisting of a generator and a single load is shown. The two currents must of course be numerically equal but of opposite sign; if we call them both I_{AB} as shown in Figure 1*A* we naturally arrive at the impossibility that a quantity is equal to its own negative value. To avoid this difficulty it is evidently necessary to give the current through the load a different designation than the current through the generator. This the authors very cleverly accomplished by the introduction of an additional terminal so that now the currents through the load and through the generator carry different labels. There can be no quarrel with this solution, but it should be pointed out that if there should be *n* load branches instead of the one shown in Figure 1, the introduction of *n* additional terminals will be required to make this system work. I feel that many engineers dealing with a circuit, where there are a number of branches between two points, will prefer to designate these currents by a numerical subscript, in addition to giving the two terminals between which the current flows. In other cases, one might, for convenience sake, designate the current as for instance I_L, I_C when the first branch happens to be inductive, the second one capacitive, and when there are no other branches of the same nature in the circuit. Applying this to the circuit shown in Figure 1 of the article one might designate the current flowing through the generator as I_6 while the current flowing in the impedance Z would be designated as I_Z. The subscripts *a* and *b* then are added to these values to indicate the direction in which current will be counted as positive. The equation pertaining to this figure then will read as shown in the accompanying Figure 2.

One of the most instructive examples involving the designation of current and voltages may be found in the case of a resonant circuit. The case of series resonance as shown in Figure 3*A* of this letter is usually mathematically treated by stating that the current in the inductance is equal to the current in the capacitor since we are dealing with a single-loop closed circuit. The voltages across the inductance and the capacity on the other hand are 180 degrees out of phase. When it is desired to maintain a certain current in this circuit and the resistance *R* is diminished to the limit zero the generator also must be diminished to zero and we finally wind up with just the inductance and the capacity and a current of oscillatory nature. The vector diagram consequently winds up with the two voltages across the inductance and the capacity numerically equal and 180 degrees out of phase, and the current in the two components alike. In the case of parallel resonance, we consider the voltage applies to the inductance and to the capacity as equal while the currents—in the case of zero resistance—are numerically exactly equal, but 180 degrees out of phase, resulting in zero current furnished by the generator. But the two circuits represent now exactly the same physical phenomenon, namely a resonant circuit in oscillation. The man who got the circuit shown in Figure 3*A* into oscillation and then removed *R* and the generator will insist that the currents in the capacitor and in the inductance were always the same and still are the same while the voltages are 180 degrees out of phase while the man of circuit in Figure 3*B* will claim that the voltages across the inductance and capacitive branch were always the same but that in the loss-free state the currents are now exactly 180 degrees out of phase, and not alike. The question of whether in an oscillating circuit the current in the inductance and the capacity is the same, but the voltages 180 degrees out of phase, or vice versa, is consequently an idle one because it evidently simply depends on the viewpoint of the observer. If one decides to call the current through the capacitor positive when it flows from *A* to *B* through the capacitor, and the current through the inductance as positive when it flows from *B* to *A*, then the two currents are alike but if one decides to call them both positive when they flow through the respective components from *A* to *B* then they are 180 degrees out of phase. Not one iota has been changed however on the actual physical phenomenon.

WALTHER RICHTER (F '42)

(Allis-Chalmers Manufacturing Company, West Allis, Wis.)

Institute Correspondence

To the Editor:

It seems that it is about time for an improvement to be effected in the manner of handling correspondence between the Institute and its members. This specifically refers to:

1. Voting ballots.
2. Notice of publication of new papers.
3. Other literature of relatively secondary importance.

At the present time in order for a member to vote in an election he is forwarded a self-addressed, unstamped envelope for returning his ballot. In all probability many ballots never are returned because there is no stamp affixed to the envelope and it is set aside until one is procured. Many times the unused ballot ends up in the waste basket, being too late for use and qualification.

The same analysis might be applied to the mailing and handling of publication notices and literature of secondary importance. At the present time these are mailed in unsealed envelopes; although often important and of interest to a member they likewise prematurely end up in a waste basket because they get placed in the file with other advertising information mailed at underclass rates.

As a service to members, I believe that all mail forwarded to members, with the exception of the monthly magazine, should be sent as first class mail so as to receive the member's attention. Any correspondence requiring an answer likewise should have a self-addressed stamped envelope enclosed for prompt action.

This idea is put forth in the interest of good business. What large business or corporation would send out proxies to their stockholders without enclosing a stamped envelope for its return? Also, how many use second class mail privileges for mailing their dividends? A company that wants to protect its integrity and promote its business ideals would not attempt any action of this type.

I doubt if there is any member who would begrudge spending three cents for a stamp for returning voting ballots, but it is just the principle of the matter. If the Institute's financial condition is in such bad straits that it cannot afford to handle all its business by first class mail, then it is time to increase the advertising matter and eliminate correspondence of secondary importance.

J. RICHARD MILLER, JR. (A '45)

(Assistant electrical engineer, Tennessee Valley Authority, Chattanooga, Tenn.)

Further Education for the Engineer

To the Editor:

Several articles have appeared in *ELECTRICAL ENGINEERING* on the education of the undergraduate, but none, as far as I know, on the graduate now out in industry. Engineers in firms having training courses probably have their training prescribed, but when the education is voluntary and independent the student may find himself adrift without compass or oar.

In my own case I finished school 11 years ago, have worked for the same firm ever since. While finding the work agreeable it lacks professional contacts, being 100 miles from St. Louis and twice as far from the Urbana Section of the AIEE. So, when I began to feel the need for further education, the planning thereof depended solely on myself.

The first part was easy. Every engineer is supposed to understand differential equations. I was not sure why, but started there. Not very difficult, though I discovered that some authors wrote for their own amazement, others to prevent overcrowding at the top by making it hard for the ignorant. I later found that such styles are not peculiar to texts on differential equations.

After elementary differential equations I had no idea where to turn. By mistake I previously had purchased a book on automatic controls which I kept because of its extensive bibliography; using this as a guide I borrowed one book after another from the Engineering Societies Library, each just long enough to realize it was beyond me. I was about to give up when I discovered the series of texts of the General Electric advanced course in engineering, the first of which I purchased. My search for subject matter is ended temporarily, though I often wonder if there are other works better suited for independent study. A

text designed for use under an instructor is not necessarily the best for that. As an example, I might cite one problem in Doherty and Keller's "Mathematics of Modern Engineering":

It can be shown easily that the force on a charge moving in an electromagnetic field is given by $F=q(v/c \times B)$.

It may be easy, but it took me six months, including a detour through 600 pages of another text. An instructor would have written it out for those who did not understand it. A little late to be realizing the advantages in formal education.

Things like that make me wonder whether I am getting a solid education or wandering aimlessly up byways. At the moment I am trying to decide whether to buy a book on operational calculus or be content with a very general knowledge of the subject for a while and push on to something else. Any with ideas on advanced education hereby are assured of a listener.

GEORGE D. JOHNSON (A'45)

(Electrical engineer, Valier Coal Company, Valier, Ill.)

NEW BOOKS • • • • •

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

TECHNIQUES IN EXPERIMENTAL ELECTRONICS. By C. H. Bachman. John Wiley and Sons, New York, N. Y.; Chapman and Hall, London, England, 1948. 252 pages, illustrations, diagrams, charts, tables, $8^1/_2$ by $5^1/_4$ inches, cloth, $3.50. Of interest to those engaged in production or research in the field, this book is concerned primarily with controlled beams of charged particles in vacua, or at very low pressures. Such topics as methods of applying and using fluorescent materials, cathode coatings, tungsten characteristics, and vacuum glass blowing techniques are discussed.

TECHNIQUE OF MICROWAVE MEASUREMENTS. (Massachusetts Institute of Technology, Radiation Laboratory Series number 11.) Edited by C. G. Montgomery. McGraw-Hill Book Company, New York, N. Y., and London, England, 1947. 939 pages, illustrations, diagrams, charts, tables, $9^1/_4$ by 6 inches, cloth, $10. This volume describes in detail the procedures for measuring the properties of microwaves and the circuits in which they are used. Topics include standing-wave measurements and the determination of impedance; measurement of wave length and frequency; measurement of power and attenuation; various microwave devices such as directional couplers, spectrum analyzers, and impedance bridges.

(The) TRANSFER OF MATERIAL, TEMPERATURE AND STABILITY IN THE ELECTRIC WELDING ARC. A résumé of published information. Technical Report, reference Z/T61. By J. C. Needham. British Electrical and Allied Industries Research Association, 15 Savoy Street, London, W.C. 2, England, 1947. 22 pages, illustrations, diagrams, charts, tables, 11 by $8^1/_2$ inches, paper, 7s.6d. The three main parts of this report cover: the physical state of the material during actual transference, the methods employed in the investigation, and the measurement of the forces at the electrodes; second, the methods for measuring arc temperatures, and data for both d-c and a-c arcs; third, both the mechanical and electrical stability of the arc, together with the inherent properties of the arc.

TROUBLES OF ELECTRICAL EQUIPMENT. By H. E. Stafford. Third edition. McGraw-Hill Book Company, New York, N. Y., and London, England, 1947. 455 pages, illustrations, diagrams, charts, tables, $9^1/_4$ by 6 inches, cloth, $4.50. This manual deals with both a-c and d-c equipment usually found in the average industrial plant, covering symptoms, causes, and remedies. The material on transformers, relays, and storage batteries has been revised and enlarged in this third edition, and new tables and diagrams have been added. A tabular presentation for quick reference is provided in each section.

VADE-MECUM (Radiolampen) 2 parts 1948. By P. H. Brans. Published by P. H. Brans, Limited, Antwerp, Belgium. 198 pages, supplement, 96 pages, illustrations, tables, $11^1/_2$ by 8 inches, paper. This regularly revised manual covers tubes made all over the world. The type of tube, manufacturer, voltage, and base connection are given. The tubes are classified according to their heater-voltage with a general index arranged by tube type. A list of manufacturers in Europe, America, Africa, Asia, and Oceania is included.

FUNDAMENTALS OF ELECTRICITY AND MAGNETISM. By L. B. Loeb. Third edition. John Wiley and Sons, New York, N. Y.; Chapman and Hall, London, England, 1947. 669 pages, diagrams, charts, tables, $9^1/_4$ by $5^3/_4$ inches, cloth, $6. Using calculus and the gaussian system of units, this volume presents the various concepts of electricity and magnetism in terms of experimental observations and the logical deductions and inferences based thereon.

ANALYSIS AND SYNTHESIS OF LINEAR SERVOMECHANISMS. By A. C. Hall. Technology Press, Massachusetts Institute of Technology, Cambridge, Mass., 1947. 193 pages, diagrams, charts, tables, 11 by $8^1/_2$ inches, paper, $2.50. A formulation of a servomechanism design procedure based primarily upon an analysis of the system response to sinusoidal inputs of various frequencies. The methods developed are based upon the characteristics of the servomechanism transfer function. Following the discussion of compensating functions, their physical realization is considered using several different types of circuits. Advantages and shortcomings of the various compensating devices are discussed.

(THE) ARCHITECTS MANUAL OF ENGINEERED SOUND SYSTEMS (including Sound Symbols, Definitions, and Specifications). Radio Corporation of America, Engineering Products Department, Architectural Relations, Sound Equipment Section, Camden, N. J., 1947. 288 pages, illustrations, diagrams, charts, tables, $11^1/_2$ by 9 inches, fabrikoid, $5. Serves as a guide for the construction of sound systems in modern buildings. Microphones, amplifiers, loud-speakers, and the controls for these instruments are considered as well as the sound film projector. Typical layouts and specifications for schools, hospitals, auditoriums, churches, industrial buildings, and hotels are given. A glossary of terms and symbols is included.

COLLEGE PHYSICS, Complete Edition. Electricity, Magnetism, Optics. By F. W. Sears and M. W. Zemansky. Addison-Wesley Press, Inc., Cambridge 42, Mass., 1948. 848 pages, illustrations, diagrams, charts, tables, $9^1/_4$ by 6 inches, cloth, $3.50. An adaptation of the Sears' "Principles of Physics" series, this text puts the emphasis on physical principles. Those parts of the original text that come within the scope of intermediate physics and needed the aid of calculus have been removed or rewritten in simpler form. In addition to the standard material on electricity, magnetism, and optics, this volume briefly discusses radioactivity, atomic, and nuclear physics.

CORROSION HANDBOOK. Edited by H. H. Uhlig and sponsored by The Electrochemical Society, Inc., New York, N. Y. John Wiley and Sons, New York, N. Y.; Chapman & Hall, London, England, 1948. 1,188 pages, illustrations, diagrams, charts, tables, $9^1/_4$ by 6 inches, cloth, $12. Provides a condensed summary of information covering all phases of corrosion, including within its scope a cross-section of scientific data and industrial experience. Quantitative rather than qualitative data are considered. Current corrosion theory is covered as well as corrosion testing. More than 100 authorities in the field contributed.

CURRENT-COLLECTING BRUSHES IN ELECTRICAL MACHINES. By M. E. Hayes. Sir Isaac Pitman and Sons, Ltd., London, England, 1947. 191 pages, illustrations, diagrams, charts, tables, $8^3/_4$ by $5^1/_2$ inches, cloth, 21s. Beginning with introductory chapters on carbon as a material and on the various types of carbon brushes, this comprehensive work proceeds with a detailed treatment of the design and use of such brushes. The principles and effective operation of current collecting devices are discussed with attention to wear and maintenance problems. A detailed table is given for the selection of brush quality.

ELECTRON AND NUCLEAR PHYSICS. By J. B. Hoag. Third edition revised by S. A. Korff. D. Van Nostrand Company, New York, N. Y., 1948. 522 pages, diagrams, charts, tables, $8^3/_4$ by $5^1/_2$ inches, cloth, $5. Aims to present modern physics at the college level. The major changes and differences in this edition are the inclusion of the new material developed in the past few years. This includes the newer accelerating devices, the new experimental techniques, modern vacuum tubes, and a discussion of the neutron experiments and their bearing on the structure of the nucleus

ESSAYS IN RHEOLOGY. Edited by the British Rheologists' Club. Pitman Publishing Corporation, New York, N. Y., and Chicago, Ill., 1947. 103 pages, diagrams, charts, tables, $8^3/_4$ by $5^1/_4$ inches, cloth, $3. Based on papers and discussion of the British Rheologists' Club 1944 Conference. Contains seven essays: the rheology of metals, polymers and liquids; the relationship between compression and shear tests; the time-variations of stress and strain; rheological nomenclature and symbols; and the applications of rheology to medical science, naval problems, and the fine arts.

FRACTIONAL HORSEPOWER ELECTRIC MOTORS. By C. G. Veinott. Second edition. McGraw-Hill Book Company, New York, N. Y., Toronto, Ontario, Canada, London, England, 1948. 554 pages, illustrations, diagrams, charts, tables, $9^1/_4$ by 6 inches, cloth, $5. For those engaged in the design, manufacture, installation, maintenance, or repair of fractional horsepower motors. It discusses what types are available, what makes them run, and what they will do, together with a detailed analysis of testing methods. This edition conforms to the standards of the American Standards Association, the National Electrical Manufacturers Association, and the AIEE.

INDUSTRIAL ELECTRIC FURNACES AND APPLIANCES, Volume II. By V. Paschkis. Interscience Publishers, Inc., New York, N. Y., and London, England, 1948. 320 pages, illustrations, diagrams, charts, tables, $9^1/_4$ by 6 inches, cloth, $8. Covers resistance furnaces and appliances, induction and high-frequency capacitance heating, and the selection of furnaces. A fairly rigid classification of furnaces is made, and applications for each general class are listed. The electrical fundamentals of induction and capacitance heating are discussed only briefly, and no attempt is made to cover specific technologies such as drying and quenching.

INTERRUPTORES DE CORRIENTE ALTERNA EN ALTA TENSIÓN. By S. Gerszonowicz, Facultad de Ingenieria de Montevideo, Uruguay, 1947. Obtainable through Stechert-Hafner, Inc., 31 East Tenth Street, New York 3, N. Y., and Editorial Médico-Quirúrgica, 615 Diagonal Norte, Buenos Aires, Argentina. 414 pages, illustrations, diagrams, charts, tables, 208 figures, 10 by 7 inches, paper, $7.50. Detailed treatment of a-c power circuit breakers. Chapters 1–3 discuss the basic phenomena underlying the circuit breaker's function and operation. Chapters 4–9 describe the different types of circuit breakers, of American and European manufacturers, especially air and oil circuit breakers, their operation and tests. Chapters 10–13 discuss critically American, European, and international power circuit breaker standards, and chapter 14 considers the selection of circuit breakers. A bibliography of 450 items is included.

KLYSTRONS AND MICROWAVE TRIODES. (Massachusetts Institute of Technology, Radiation Laboratory Series volume 7.) By D. R. Hamilton, J. K. Knipp, J. B. H. Kuper, and others. McGraw-Hill Book Company, New York, N. Y., Toronto, Ontario, Canada, London, England, 1948. 533 pages, illustrations, diagrams, charts, tables, $9^1/_4$ by 6 inches, cloth, $7.50. Primarily concerned with low-power microwave triodes and klystrons, and their performance as local oscillators, signal generators, and low-power transmitters. A theoretical treatment is given covering the use of triodes and klystrons as mixers, amplifiers, oscillators, and frequency multipliers. The performance of planar triodes with small electrode spacing as low-power sources of CW and pulse power is dealt with, as well as the theory and use of 2-cavity and reflex klystrons.

MICROWAVE DUPLEXERS. Edited by L. D. Smullin and C. G. Montgomery. (Massachusetts Institute of Technology, Radiation Laboratory Series, vol. 14.) McGraw-Hill Book Company, New York, N. Y., Toronto, Ontario, Canada, London, England, 1948. 437 pages, illustrations, diagrams, charts, tables, $9^1/_4$ by 6 inches, cloth, $6.50. Deals with the general problem of using a single antenna for both receiving and transmitting, and is therefore mainly of interest for pulsed transmission applications. It discusses the low-level properties of TR and ATR tubes and the methods for their design. The high-level operation is described in detail and discussed in connection with the properties of the gases used for filling the tubes.

MICROWAVE RECEIVERS. (Massachusetts Institute of Technology, Radiation Laboratory Series, volume 23.) Edited by S. N. Van Voorhis. McGraw-Hill Book Company, New York, N. Y., Toronto, Ontario, Canada, London, England, 1948. 618 pages, illustrations, diagrams, charts, tables, $9^1/_4$ by 6 inches, cloth,

$8. All of the elements making up a wide-band receiver are covered. After a discussion of the individual circuit types from which a complete receiver is made, the book takes up general matters concerning the assembly, testing and maintenance of microwave receivers, and then deals with actual receivers chosen as examples because they are typical of the important combinations of circuits.

NATIONAL ELECTRONICS CONFERENCE, PROCEEDINGS, volume 3, Chicago, Ill., November 3–5, 1947. (Obtainable from Doctor R. R. Buss, Electrical Engineering Department, Northwestern University, Evanston, Ill.) 1948. 698 pages, illustrations, diagrams, charts, tables, 9 by 6 inches, paper, $4. Some 60 papers are printed in full, classified under the following subjects: noise suppression, electronic instrumentation, coaxial elements, microwaves, computers, electronic circuit analysis, industrial electronics, nucleonics, communication, television, antennas, FM broadcasting, military applications, and general basic or descriptive papers. Brief abstracts only are provided for 20 other papers that are scattered through the several subject groups.

NEW WEAPONS FOR AIR WARFARE, FIRE-CONTROL EQUIPMENT, PROXIMITY FUSES, AND GUIDED MISSILES. (Science in World War II.) Office of Scientific Research and Development. Edited by J. C. Boyce, with a foreword by R. C. Tolman. (An *Atlantic Monthly* Press Book) Little, Brown and Company, Boston, Mass., 1947. 292 pages, illustrations, $8^1/_2$ by $5^1/_2$ inches, cloth, $4. Describes the work done by the National Defense Research Committee of the Office of Scientific Research and Development on devices to control the behavior of shells, bombs, rockets, and other missiles. Specifically, it covers fire control, proximity or VT-fuses for rotating and nonrotating shells, and guided missiles.

COMPUTING MECHANISMS AND LINKAGES. (Massachusetts Institute of Technology, Radiation Laboratory Series, volume 27.) By A. Svoboda, edited by H. M. James. McGraw-Hill Book Company, New York, N. Y., 1948. 359 pages, diagrams, charts, tables, $9^1/_4$ by 6 inches, cloth, $4.50. A general treatment is provided of computing mechanisms in general, and a detailed study is made of the design of bar linkages for use in computers. A full account is included of novel methods for the design of bar linkages serving as generators of functions of one and two independent variables. Special attention is paid to the design of the bar linkage multipliers.

CRYSTAL RECTIFIERS. (Massachusetts Institute of Technology, Radiation Laboratory Series, volume 15.) By H. C. Torrey and C. A. Whitmer, edited by S. A. Goudsmit and others. McGraw-Hill Book Company, New York, N. Y., and London, England, 1948. 443 pages, illustrations, diagrams, charts, tables, $9^1/_4$ by 6 inches, cloth, $6. Discusses the theory, properties, and use of silicon and germanium point-contact rectifiers which have been developed for use as microwave converters and for other circuit applications. Treatment of the theory by semiconductors, of the semiconductor metal contact, of frequency conversion by rectifiers and of noise generation by crystals is followed by engineering information on the production and use of practical crystal types.

ELECTRIC POWER AND GOVERNMENT POLICY, A SURVEY OF THE RELATIONS BETWEEN THE GOVERNMENT AND THE ELECTRIC POWER INDUSTRY. Twentieth Century Fund, 330 West 42d Street, New York, N. Y., 1948. 860 pages, charts, maps, tables, $9^1/_4$ by 6 inches, cloth, $5. This volume is based upon the findings of a comprehensive survey of the relations between government and the electric power industry. The project was designed to give the public an unbiased picture of how these relations have worked out, and to develop some constructive planks for a national power policy platform in the interest of the public as a whole.

ELECTRONIC INSTRUMENTS. Edited by I. A. Greenwood, J. V. Holdam, and D. MacRae. (Massachusetts Institute of Technology, Radiation Laboratory Series, volume 21.) McGraw-Hill Book Company, New York, N. Y., Toronto, Ontario, Canada, London, England, 1948. 721 pages, illustrations, diagrams, charts, tables, $9^1/_4$ by 6 inches, cloth, $9. Details of the design of simple electronic computing systems are followed by several illustrative applications to the solution of the aircraft navigation problem and the synthesis of radar data for training purposes. A second part is devoted to the practical aspects of the design of lightweight, low-power electronic servomechanisms, and a number of practical examples are included. The last two parts treat the practical design of accurately stabilized power supplies and present problems of design and construction of prototype equipment with emphasis on lightweight techniques and the limitations of available components.

PHÈNOMÈNÈS RADIOACTIFS ET INTRODUCTION À LA PHYSIQUE NUCLÈAIRE. By G. Gueben. Èditions Desoer, Liège, Belgium; Dunod, Editéur, Paris, France, 1948. 261 pages, illustrations, diagrams, charts, tables, $9^1/_2$ by 6 inches, paper, 550 Fr. frs. (available in United States from Stechert-Hafner, 31 East Tenth Street, New York, N. Y., $6). Based on courses given at the University of Liege, this volume traces the development of our knowledge of radioactivity and presents the basic principles of nuclear physics. Beginning with an historical survey, early chapters discuss ionization of gases, methods of observing radioactivity, and the nuclear emissions which are known. Radioactive elements and isotopes, natural and artificial fission, and occurrence of radioactivity then are treated. The last chapter considers nuclear structure.

LA PHOTOÈLASTICITÈ. By A. Pirard. Dunod, Editéur, Paris, France, 1947. 419 pages, illustrations, diagrams, charts, tables, $9^1/_2$ by 6 inches, paper, 1550 frs. Following an extended discussion of the theory of elasticity, this text takes up the subject of photoelasticity from both the theoretical and practical points of view. Biréfringence and polarisation are discussed, materials and equipment for photoelastic examination are described in detail, and practical applications are demonstrated with examples of photoelastic studies.

PHOTOELASTICITY, volume 2. By M. M. Frocht. John Wiley and Sons, New York, N. Y.; Chapman and Hall, London, England, 1948. 505 pages, illustrations, diagrams, charts, tables, $9^1/_4$ by 6 inches, cloth, $10. This treatise on advanced principles and methods includes the following: essential elements of the theory of elasticity; a critical examination of the influence of the physical constants on the state of stress in two dimensions; a broad survey of the methods for the determination of the sums of the principal stresses with special emphasis on the numerical solution of Laplace's Equations. Also presents the theory and technique of 3-dimensional photoelasticity with applications to stress concentrations.

S P I HANDBOOK. Society of the Plastics Industry, Inc., 295 Madison Avenue, New York, N. Y., 1947. 451 pages, illustrations, diagrams, charts, tables, $9^1/_4$ by 6 inches, fabrikoid, $7.50 to nonmembers, $4.50 to members. The results of six years of planning and four years of effort by 300 technicians in the plastics industry, this handbook covers the subjects of primary importance to good engineering of plastics. A classification of plastics molding materials is given. Molding processes, design of molded articles, cementing and assembling testing, mold design, machining and finishing are covered. Included also are standards for the design of inserts, for tolerances on molded plastic parts, and for laminated products.

SYMPOSIUM ON LARGE-SCALE DIGITAL CALCULATING MACHINERY, PROCEEDINGS, jointly sponsored by the Navy Department, Bureau of Ordnance, and Harvard University at the Computation Laboratory, January 7–10, 1947. Harvard University Press, Cambridge, Mass., 1948. 302 pages, illustrations, diagrams, charts, tables, $10^3/_4$ by $7^3/_4$ inches, cloth, $10. More than 30 papers, presented by specialists, are included in this symposium on the design, construction, operation, and application of this rapidly developing, recent type of mathematical tool. The papers are grouped by the separate session subjects: existing calculating machines; logic of large-scale calculating machinery; storage devices; numerical methods and suggested problems; sequencing, coding, and problem preparation; input and output devices; conclusions, and discussion.

VACUUM-TUBE CIRCUITS. By L. B. Arguimbau. John Wiley and Sons, Inc., New York, N. Y.; Chapman and Hall, Limited, London, England, 1948. 668 pages illustrations, diagrams, charts, tables, $8^1/_2$ by $5^1/_2$ inches, cloth, $6. Emphasizing physical concepts and ideas rather than detailed discussion of actual circuits, this book includes the fundamental material needed by the reader who is unacquainted with electronics. It deals at some length with frequency modulation, transient response, and the generation of microwaves, with special treatments of inverse feedback, video-amplifier transients, pulses, and television. A knowledge of a-c circuits, calculus, and Fourier series is assumed.

VACUUM TUBES. By K. R. Spangenberg. McGraw-Hill Book Company, New York, N. Y., London, England, Toronto, Ontario, Canada, 1948. 860 pages illustrations, diagrams, charts, tables, $9^1/_4$ by 6 inches, cloth, $6. Based on a course given at Stanford University, this book is concerned with the determination of vacuum-tube characteristics in terms of the electron action within the tube. It attempts to bridge the gap between the physical laws that lie behind the electron behavior and the external characteristics of the tubes themselves. The outstanding tube types are dealt with individually. Recent advances in this field are covered.

ELEMENTARY INDUSTRIAL ELECTRONICS. By W. R. Wellman. D. Van Nostrand Company, New York, N. Y., Toronto, Ontario, Canada, London, England. 1948. 371 pages, illustrations, diagrams charts, tables, $9^1/_4$ by 6 inches, cloth, $4. Of interest to the beginner rather than to the advanced student, this book contains the basic principles involved in electronic equipment now in industrial use. Following a review of a-c fundamentals, the basic principles of vacuum tubes and gas-filled tubes are considered. Kenotrons, various rectifiers and amplifiers are discussed as well as high-frequency heating and electronic control of motors, generators, and resistance welding. Photoelectric devices and electronic lamps are also covered.

ELEMENTS OF ELECTRICAL ENGINEERING. By W. J. Creamer. McGraw-Hill Book Company, New York, N. Y., Toronto, Ontario, Canada, London, England, 1948. 344 pages, illustrations, diagrams, charts, tables, $9^1/_4$ by 6 inches, cloth, $4. Serving as a comprehensive introduction to electrical engineering, this book presents its subject matter in a logical sequence with ample descriptive material. The topics dealt with are d-c analysis, the properties of conductors and insulators, various types of meters and measuring networks, electrodynamic principles of d-c motors and generators, and elementary electronics.

ELEVEN AND FIFTEEN-PLACE TABLES OF BESSEL FUNCTIONS OF THE FIRST KIND, TO ALL SIGNIFICANT ORDERS. By E. Cambi. Dover Publications, 1780 Broadway, New York, N. Y., 1948. 154 pages, tables, $10^3/_4$ by $8^1/_2$ inches, cloth, $3.95. The main tables give $J_n(x)$ for x ranging from 0 to 10.5 at intervals of 0.01, to 11 places. Supplementary tables give $J_n(x)$ for x ranging from 0 to 0.500 at intervals of 0.001, to 15 places, and Taylor series for J_n of even order for $x=2$ to 10 inclusive. The introduction contains an explanation of the tables and graphs which show their accuracy.

ETUDE DE L'ÉTAGE AMPLIFICATEUR A RÉSISTANCES By J. Schérer, prefacé de E. Fromy. Dunrod, Paris, France, 1947. 124 pages, diagrams, charts, tables, $9^1/_4$ by 6 inches, paper, 480 frs. Considers analytically and functionally the stages of resistance-coupled amplifiers, taking into account the action and effects of the various included elements. The respective importance of these elements is taken into consideration, and certain approximations are worked out for the simpler aspects of the problems involved.

F-M TRANSMISSION AND REGEPTION. By J. F. Rider and S. D. Uslan. John F. Rider Publisher, Inc., 404 Fourth Avenue, New York, N. Y., 1948. 409 pages, illustrations, diagrams, charts, tables, $8^1/_4$ by $5^1/_2$ inches, paper, $2.70. The first half presents the underlying theory of frequency modulation and indirect frequency modulation (pulse modulation), discusses the propagation of frequency-modulation signals and the basic characteristics of frequency-modulation transmitters, and presents an analysis of transmitters in use today. The second part deals with frequency-modulation receiving antennas and the frequency-modulation receiver. Four currently used types of frequency-modulation detectors are covered in detail. The last two chapters describe the alignment and servicing of receivers.

FREQUENCY MODULATION, volume I. Edited by A. N. Goldsmith and others, January 1948. *R C A Review*, Radio Corporation of America, RCA Laboratories Division, Princeton, N. J., 1948. 515 pages, illustrations, diagrams, charts, tables, $9^1/_4$ by 6 inches, cloth, $2.50 plus 20 cents postage. Papers from various technical periodicals for the years 1936–47. Book is divided into four parts dealing with general information, transmission, reception, and miscellaneous subjects. Some papers are reprinted in full, others in summary form. Appendixes contain a frequency modulation bibliography and a list of papers dealing with frequency-modulation station placement and field survey techniques.

THE GENIUS OF INDUSTRIAL RESEARCH. By D. H. Killeffer. Reinhold Publishing Corporation, New York, N. Y., 1948. 263 pages, charts, $9^1/_4$ by 6 inches, cloth, $4.50. This treatment of modern industrial research and its methods is intended primarily to guide the ambitious young researcher to a better understanding and a surer mastery of his craft. The material is mostly from the field of industrial chemistry. The accounts of how many important modern developments were achieved are quoted directly from the original presentations.

GERMAN ELECTROPLATING INDUSTRY, PB 32158. By G. E. Gardam. Mapleton House, Publishers, 5415 17th Avenue, Brooklyn, N. Y., 1947. 72 pages, illustrations, diagrams, tables, $8^1/_4$ by $5^1/_2$ inches, paper, $5. The operating processes of some 20

German firms and research institutes are described briefly, with analyses of solutions used, and other technical data. A translation of a German specification for the testing of zinc-plate parts is appended.

HOUSEHOLD ELECTRIC REFRIGERATION (including Gas Absorption System). By J. F. Wostrel and J. G. Praetz. Second edition. McGraw-Hill Book Company, New York, N. Y., and London, England, 1948. 458 pages, diagrams, charts, tables, $9^1/_4$ by 6 inches, cloth, $4.50. Beginning with a simple explanation of how refrigerators work, this book continues with detailed practical methods and data on installation, testing, servicing, adjusting, trouble shooting, and repairing. This revised edition has been amplified to include the mechanical details and service instruction for refrigerators introduced since the previous edition.

INDUSTRIAL RESEARCH, 1947. Advisory editor, P. Dunsheath. Todd Reference Books Limited, London, England, and New York, N. Y.; British Distributors: George G. Harrap and Company, Ltd., 182 High Holborn, London, England, W. C. 1. 535 pages, $8^3/_4$ by $5^1/_2$ inches, cloth, 25s. This British Empire directory contains statements on the character and activities of government, public, and private organizations which have industrial research programs. Careers in industrial research are described briefly, with information on university requirements, grants, and so forth. Books, periodicals, and films of interest are given in classified groups. The volume also contains lists of laboratories, technical colleges, consultants, libraries, and a "who's who" in industrial research.

INDUSTRIAL WEIGHING. By D. M. Considine. Reinhold Publishing Corporation, New York, N. Y., 1948. 553 pages, illustrations, diagrams, charts, tables, $9^1/_4$ by 6 inches, cloth, $10. Written for students, engineers, designers, and users of scales, this book provides a comprehensive study of the subject of scale design and engineering, and of the uses of scales in the process industries. The first part reviews basic scale mechanics, design, and construction of modern scales, scale installation, and maintenance. The uses are described in part 2.

INTRODUCTION A L'ÉTUDE DES RÉSEAUX ÉLECTRIQUES. By M. Parodi, preface by L. de Broglie, Société d'Édition d'Enseignement Supérieur, 99 Boulevard Saint-Michel, Paris 5e, France, 1948. 54 pages, diagrams, tables, 10 by $6^1/_2$ inches, paper, 200 frs. The three chapters of this mathematical study of electric networks cover respectively the characteristic matrices of connected networks, applications of the transformation theory to such networks, and an analysis of the energy-producing properties of passive networks.

INTRODUCTION TO THE DIFFERENTIAL EQUATIONS OF PHYSICS. By L. Hopf, translated by W. Nef. Dover Publications, New York, N. Y., 1948. 154 pages, diagrams, $6^1/_2$ by $4^1/_4$ inches, cloth, $1.95. Basic mathematical concepts and methods are developed in close connection with the physical problems to which they can be traced historically. The intuitive rather than the formal aspects of mathematical developments are emphasized, and the necessary mathematical background, beyond elementary calculus, is introduced along with the discussion.

INTRODUCTION TO THE PHYSICS OF METALS AND ALLOYS. By W. Boas. John Wiley and Sons, New York, N. Y., 1947. 193 pages, illustrations, diagrams, charts, tables, $9^3/_4$ by 6 inches, cloth, $3.50. Based on a series of lectures in physical metallurgy, this book has been written to supply a basis for further work in the field. The main principle underlying the text is that the properties and arrangement of the crystals determine the properties of polycrystalline aggregates. The principles of X-ray analysis, the physical properties of metal crystals and polycrystalline aggregates, and the changes in the properties of metals due to alloying and heat treatment are the main areas covered.

(AN) INTRODUCTION TO THE THEORY OF SEISMOLOGY. By K. E. Bullen. University Press, Cambridge, England; Macmillan Company, New York, N. Y., 1947. 276 pages, diagrams, charts, tables, $8^3/_4$ by $5^1/_2$ inches, cloth, $4. Based on lectures given to undergraduate students. Begins with a consideration of the mathematical theories of elasticity, and of vibrations and waves, followed by the wave theory applied to problems on wave motion in an elastic body, and the derivation of results special to seismology, the essential principle of the seismograph, application of seismological data, and earthquake phenomena.

KINEMATICS OF MACHINES. By L. M. Sahag. Ronald Press Company, New York, N. Y., 1948. 249 pages, illustrations, diagrams, $9^1/_2$ by 6 inches, cloth, $4. Following introductory chapters on fundamental conceptions and motion in machines, the text is divided into separate detailed discussions of the particular actions and mechanisms dealt with. In the solution of problems in velocities and accelerations the graphic method has been applied in preference to the analytic method.

LIGHTING DESIGN. By P. Moon and D. E. Spencer. Addison-Wesley Press, Kendall Square, Cambridge 42, Mass., 1948. 482 pages, illustrations, diagrams, charts, tables, $9^1/_4$ by 6 inches, cloth, $5. This book has two aims: to provide a text on lighting which rises above the descriptive level and which presents fundamental principles in a quantitative manner; and to present a comprehensive design method that can be used by practicing engineers in devising high-quality lighting systems for rooms. It gives data on nomenclature, lamps, and materials, the calculation of light, and the design of systems of exterior lighting.

MANUAL OF STRUCTURAL DESIGN. By J. Singleton. Third edition. H. M. Ives and Son, 415 Kansas Avenue, Topeka, Kans., 1947. 336 pages, diagrams, charts, tables, $10^1/_4$ by 7 inches, fabrikoid, $6. Intended for the practicing engineer, this book applies the fundamentals of structural design in the formulation of data that bear directly on specific cases. It contains the latest specifications of the American Institute of Steel Construction and other new material. The included data are presented chiefly in the form of tables or graphs for more effective use.

MICROWAVE MAGNETRONS. Edited by G. B. Collins. (Massachusetts Institute of Technology, Radiation Laboratory Series, volume 6.) McGraw-Hill Book Company, New York, N. Y., Toronto, Ontario, Canada, London, England, 1948. 806 pages, illustrations, diagrams, charts, tables, $9^1/_4$ by 6 inches, cloth, $9. Contains the theory, design, and operation of magnetrons in the frequency range 1,000 to 25,000 megacycles per second and the many modifications that extend the usefulness of these tubes. The circuit theory and electronics of this type of oscillator are discussed with special attention to the subjects of starting phenomena, electronic tuning, and stabilization of frequency. Applications of the magnetron principles to both pulsed and CW tubes are dealt with in full. There is a compilation of the operating characteristics of microwave magnetrons developed during the war.

MICROWAVE MIXERS. (Massachusetts Institute of Technology Radiation Laboratory Series, volume 16.) By R. V. Pound, edited by C. G. Montgomery and D. D. Montgomery. McGraw-Hill Book Company, New York, N. Y., and London, England, 1948. 381 pages, diagrams, charts, tables, $9^1/_4$ by 6 inches, cloth, $5.50. Covers the microwave portions of receivers for very-high-frequency waves. It discusses various types of receiving systems and their relative merit, and treats the conversion frequency problem in all its aspects. Practical mixers are described and their design problems are dealt with. Schemes are described for maintaining a constant absolute frequency of the local oscillator as well as those for stabilizing to a constant frequency difference between transmitter and local oscillator.

MICROWAVE TRANSMISSION DESIGN DATA. By T. Morano. McGraw-Hill Book Company, New York, N. Y., Toronto, Ontario, Canada, London, England, 1948. 248 pages, diagrams, charts, tables, $9^1/_4$ by 6 inches, cloth, $4. A practical handbook of specific design data for the use of engineers engaged in the design of microwave equipment of all kinds. It includes transmission line theory from high-frequency point of view; coaxial lines and transmission line structure; hollow pipe wave guides; wave guide structures and components; properties of dielectrics at high frequencies; cavity resonators.

MODERN METALLURGY FOR ENGINEERS. By F. T. Sisco. Second edition. Pitman Publishing Corporation, New York, N. Y., and London, England, 1948. 499 pages, illustrations, diagrams, charts, $9^1/_2$ by 6 inches, cloth, $5. This revision of a widely used textbook is of primary interest to engineers concerned with the relation of metals and metallic alloys to structures and machines. It contains information on the origin, production, composition, and properties of most of the metals used in modern engineering. Various forms of heat treatment are explained with particular reference to practical difficulties encountered. Considerable attention is given to hardenability of steel.

ORGANIZING SCIENTIFIC RESEARCH FOR WAR. (Science in World War II, Office of Scientific Research and Development.) By I. Stewart, foreword by V. Bush. Little, Brown and Company, (*Atlantic Monthly* Press Book), Boston, Mass., 1948. 358 pages, tables, $8^3/_4$ by $5^1/_2$ inches, cloth $5. Sets forth the details of the actual organization of the nation's scientists after they were mobilized for war. It outlines the over-all committees, special committees, divisions, panels, and the chairman's office of OSRD, as well as the various research groups and the office of Field Service. It tells how liaison was achieved with the armed services and allied governments, and how the administrative office functioned. Finally it surveys the process of demobilization and evaluates the procedures of the OSRD as a whole.

PRACTICAL JOB EVALUATION. By P. W. Jones. John Wiley and Sons, New York, N. Y.; Chapman and Hall, Ltd., London, England, 1948. 304 pages, illustrations, diagrams, charts, tables, $8^3/_4$ by $5^1/_2$ inches, cloth, $4. Describing the applications of wage determination to wage structures, this book emphasizes the design, installation, and salesmanship of the procedures necessary to determine the wages of employees. All plans and techniques included have been used successfully in business and in industry.

PRECISION INVESTMENT CASTINGS. By E. L. Cady. Reinhold Publishing Corporation, New York, N. Y., 1948. 356 pages, illustrations, diagrams, charts, tables, $9^1/_4$ by 6 inches, cloth, $6. This treatment of a relatively new production process tells in the first few chapters what the process is, what it does, and how it does it. Subsequent chapters detail the practical methods for getting the best results and show how the process operates to obtain the desired ends. The resources and weaknesses of the process are described, and future developments are indicated.

PRODUCTION COST TRENDS IN SELECTED INDUSTRIAL AREAS. By P. Neff, L. C. Baum, and G. E. Heilman. University of California Press, Berkeley and Los Angeles, Calif., 1948. 249 pages, charts, tables, $9^1/_2$ by 6 inches, cloth, $4. This statistical study compares manufacturing cost trends in the industrial areas of Los Angeles, Calif.; San Francisco, Calif.; Detroit, Mich.; Cleveland, Ohio; Chicago, Ill.; and Pittsburgh, Pa., for the period 1929–39. The trends in general manufacturing are considered first; then durable goods; and finally a number of selected industries are dealt with. The data utilized are taken mainly from the United States Census of Manufacturers.

PULSE GENERATORS. Edited by G. N. Glasoe and J. V. Lebacqz. (Massachusetts Institute of Technology, Radiation Laboratory Series, volume 5.) McGraw-Hill Book Company, New York, N. Y., and London, England, 1948. 741 pages, illustrations, diagrams, charts, tables, $9^1/_4$ by 6 inches, cloth, $9. Deals with the theoretical and practical aspects of the generation of power pulses, covering the ranges of 100 watts to 20 megawatts and 0.03 to 10 microseconds. The treatment is as general as possible, with emphasis on such problems as pulse formation; the effect of circuit parameters on the pulse shape; pulse power, average power, power transfer and circuit efficiency; impedance transformation; and characteristics and design of pulse transformers.

TABLES FOR THE DESIGN OF MISSILES. (Annals of the Computation Laboratory of Harvard University, volume 17.) Harvard University Press, Cambridge, Mass., 1948. 226 pages, diagrams, tables, $10^3/_4$ by $7^3/_4$ inches, cloth, $9. These tables were made to facilitate the design of missiles by permitting rapid calculation of the characteristics of the quantities affecting the behavior of a missile in flight. In the introduction, definitions of the tabulated functions, the method of computation, interpolation instructions, the use of the tables, and nonstandard ogives are considered. The major portion of the book contains complete tables of important functions with sufficiently small increments for precise work.

THEORY OF SERVOMECHANISMS. Edited by H. M. James, N. B. Nichols, and R. S. Phillips. (Massachusetts Institute of Technology, Radiation Laboratory Series, volume 25.) McGraw-Hill Book Company, New York, N. Y., Toronto, Ontario, Canada, London, England, 1947. 375 pages, diagrams, charts, tables, $9^1/_4$ by 6 inches, cloth, $5. Deals first with frequency response techniques of servomechanism design. The required mathematical background is summarized and applications are described. The second section presents a new design technique, and the relationship of the two sections is discussed. The approach makes fundamental use of statistical methods. The book closes with an account of the applications of these techniques to servomechanisms operating with pulsed data.

VIBRATION AND SOUND. By P. M. Morse. Second edition. McGraw-Hill Book Company, New York, N. Y., Toronto, Ontario, Canada, London, England, 1948. 468 pages, diagrams, charts, tables, $9^1/_4$ by 6 inches, cloth, $5.50. Intended primarily as a text for students of physics and communication engineering, this book serves as an introduction to the theory of vibration and sound and gives a series of examples of the method to be used in solving new as well as standard problems. Reflecting wartime developments, this edition includes more detail than its predecessor on radiation problems, and introduces the important subject of transient phenomena and the technique of operational calculus.

PAMPHLETS • • • • •

The following recently issued pamphlets may be of interest to readers of "Electrical Engineering." All inquiries should be addressed to the issuers.

RCA Technical Papers Index (*1947*) Volume II(b). This index, a supplement to *RCA Technical Papers Index* (1919–50), lists all published English-language technical papers on radio, electronics, and related fields, the author of which was associated with the Radio Corporation of America at the time of the paper's preparation. Copies are obtainable free, from the *RCA Review*, RCA Laboratories Division, Princeton, N. J.

Allis-Chalmers Bulletins. Two bulletins, *61B6152A* "Allis-Chalmers Network Transformers" and *03B6801* "Standardized Steam Turbine Units" are available upon request from the Allis-Chalmers Manufacturing Company, Milwaukee 1, Wis.

List of Inspected Fire Protection Equipment and Materials (January 1948). Published by Underwriters' Laboratories, Inc., this list includes and replaces all UL lists prior to January 1948. Copies are obtainable from any one of the three Underwriters' offices: 161 Sixth Avenue, New York, N. Y.; 207 East Ohio Street, Chicago, Ill.; 500 Sansome Street, San Francisco, Calif.

Tempil Topics. Number 4 "Welding Dissimilar Metals" and number 6 "Repair of Castings by Welding" of volume 3, *Tempil Topics*, are available upon request from the Tempil Corporation, 132 West 22d Street, New York 11, N. Y.

NEMA Publications. The National Electrical Manufacturers Association, 155 East 44 Street, New York 17, N. Y., has issued the following booklets: publications *39–54*, "NEMA Standards for Asbestos, Asbestos-Varnished-Cambric and Asbestos-Synthetic Insulated Wire, Cables and Cords." 38 pages, $1.50; publication *48–129*, "Specifying a Geared Steam Turbine Generator Unit (75–400 kw, inclusive)" 16 pages, 75 cents; publication *505*, "Standards for Measurement of Direct Interelectrode Capacitance," 10 pages, 80 cents.

Westinghouse Film Catalogue. A 24-page catalog (*B-3988*), listing available Westinghouse sound motion pictures and slides for industrial and civic use may be obtained free from the Film Section, Westinghouse Electric Corporation, Post Office Box 868, Pittsburgh 30, Pa.

Intermodulation Measuring Set. A brochure on the Western Electric intermodulation measuring system will be supplied free by the Electrical Research Products Division, Western Electric Company, 233 Broadway, New York 7, N. Y.

The Humanistic-Social Stem of Engineering Education. An annotated bibliography compiled by the Cooper Union Library is available free from the Librarian, Cooper Union Library, Cooper Square, New York 3, N. Y.

Ohio State Engineering Series. Two bulletins have been published by the Ohio State Engineering Experiment Station: number *131*, "Research on Flow Nozzles by the ASME Special Research Committee on Fluid Meters," $1; number *132*, "Investigation of Bridge Impacts with a Mechanical Oscillator," 75 cents.

U of I Bulletins, Volume 45. The following numbers from the University of Illinois' Bulletins, volume 45, are available: number *9*, "The Illinois Smokeless Furnace," 75 cents; number *11*, "The Railroad Dynamotor Car of the U of I and the Illinois Central Railroad," 20 cents; number *23*, "Experience in Illinois with Joints in Concrete Pavements," $1; number *26*, "The Effect of Non-Uniform Distribution of Stress on the Yield Strength of Steel," 50 cents; number *29*, "History of Building Foundations in Chicago," 40 cents; number *22*, "Effect of Eccentric Loading, Protective Shells, Slenderness Ratio, and Other Variables in Reinforced Concrete Columns," $1; number *33*, "Flexible Fatigue Strength of Steel Beams," 20 cents.

Schedule of Trade and Industrial Fairs. A supplementary schedule of trade and industrial fairs to be held throughout the world during the second half of 1948 has been compiled and issued by World's Business and Guia, the export business publications. Copies can be obtained from their offices at 440 Fourth Avenue, New York 16, N. Y.

The First 100 Years. A 1947 annual review of engineering developments at Allis-Chalmers, Milwaukee, Wis. Copies of the 1947 annual review may be obtained on request.

Isotope Chart. A chart giving data concerning various forms of isotopes of the chemical elements, of importance in atomic studies, is being distributed by the General Electric Research Laboratory, Schenectady 5, N. Y.

Table of Coefficients. A 20-page Table of Coefficients for Obtaining the First Derivative Without Differences has been prepared by the National Bureau of Standards and made available as NBS Applied Mathematics Series 2. May be obtained only from the Superintendent of Documents, United States Government Printing Office, Washington 25, D. C., at 15 cents per copy.

Westinghouse Electric Heating Guide. A 42-page illustrated manual, "Electric Heating for Homes," designed to assist in the proper application of electric heating in the home. A copy of the guide (B-3768-A), priced at $2, may be secured from any office of the Westinghouse Electric Supply Company or other distributors of Westinghouse apparatus or supplies.

The Visual Study of Nonperiodic Electric Transient Phenomena. The bulletin reports the technique employed in determining the compliance of electric fence controllers in so far as output characteristics are concerned, with the requirements of the Standard for electric fence controllers of Underwriters' Laboratories Inc., 207 East Ohio Street, Chicago 11, Ill.

Three Management Booklets. The National Foremen's Institute, Inc., Deep River, Conn., offers three booklets on problems in management, each for 25 cents. They are: "Notes on the Development of Management People," "How Supervisors Can Handle Worker Problems," and "WHO, ME?... Pointers in Job Management."

Densified Wood Made with Bakelite Resins. This new booklet, describing the uses of densified wood in engineering, is issued free by the Bakelite Corporation, 300 Madison Avenue, New York 17, N. Y.

Safe Transformer Installations. Published as "Factory Mutual Bulletin of Loss Prevention number *15.30*," copies of this paper are obtainable from the Inspection Department, Associated Factory Mutual Fire Insurance Companies, 184 High Street, Boston 10, Mass.

The Radio Amateur's Beam Pointer Guide. Published by John F. Rider, Inc., 404 Fourth Avenue, New York 16, N. Y., this guide, which shows how the operator can point his beam at any point in the world, comes complete with charts and tables for $1.

Over Jets in Action for Smoke Abatement. Free copies of this booklet, which answers questions concerning smoke abatement and control, are to be had by writing to Bituminous Coal Research, Inc., 92 Oliver Building, Pittsburgh 22, Pa.

Operation of Ammonia Machines. This brochure, numbered *AD 19-R*, includes information on ammonia compressors, mechanical refrigeration cycles, system testing, and maintenance hints. It sells for 35 cents a copy from the American Society of Refrigerating Engineers, 40 West 40 Street, New York 18, N. Y.

National Directory of Safety Films. Prepared by the National Safety Council, this is a comprehensive listing of 403 motion pictures and slide films, both sound and silent, for safety education in industry, business, farms, schools, and the home. It is classified and indexed with synopsis, source, and availability. Price is 25 cents from the National Safety Council, 20 North Wacker Drive, Chicago 6, Ill.

Powder Metallurgy. Describes the effect of particle size on the physical properties of powder metallurgy products. 6 pages. Distributed free by Micromet, Inc., 60 Park Place, Newark 2, N. J.

What Makes a Plant Fire-Safe? Free booklet listing essential points in planning and supervising plant fire safety. Write to the Inspection Department, Associated Factory Mutual Fire Insurance Companies, 184 High Street, Boston 10, Mass.

Cast Bronze Bearing Alloys Engineering Data. Discusses selection of alloys and their physical properties. First of a series, this paper lists complete engineering data, characteristics, and typical uses. For a copy, write The Bunting Brass and Bronze Company, Toledo 9, Ohio.

INDUSTRIAL NOTES ....

Sales Engineer. Edward J. Hart has joined Federal Telephone and Radio Corporation, Clifton, N. J., associate of International Telephone and Telegraph Corporation, as sales engineer, reporting to I. W. Gleason, sales manager, telephone division.

Sales Manager. John B. Land has been appointed manager of sales for the petroleum and chemical industries section of the General Electric Company's materials industries division, Schenectady 5, N. Y. Mr. Land had been connected previously with industrial sales division at General Electric's Pittsburgh office. Prior to that he was district cable specialist of the Atlantic district, working out of the Philadelphia office.

Sylvania Appointment. Edward J. Lynch has been appointed manager of warehouse service, a new department created by Sylvania Electric Products Inc. Mr. Lynch will be responsible for setting up and operating service warehouses to handle all of the company's products throughout the United States. He will make his headquarters in Salem, Mass.

Director of Electronics. Charles A. Buebling has been appointed director of electronics for the W. L. Maxson Corporation, New York, N. Y.

Allis-Chalmers Organization. Organization of a sixth region for Allis-Chalmers, Milwaukee, Wis., general machinery division's field organization under William Arthur, formerly Philadelphia district office manager, has been announced.

Eastman Purchase. The Eastman Kodak Company has purchased from General Mills, Inc., the latter's interest in Distillation Products, Inc., of Rochester,, N. Y.

Acquisition. The Stromberg-Carlson Company has taken over the complete operations of Liberty Carillons, Inc., of New York, N. Y.

TRADE LITERATURE

Selenium Rectifiers. An 8-page catalogue in color describing, illustrating, and giving engineering data on a complete line of selenium rectifiers for electroplaters, electrotypers, anodizers, and all other industrial users of a-c to d-c power conversion equipment is announced by Richardson-Allen Corporation, 15 West 20th Street, New York, N. Y.

Dow Corning Pamphlet. Information on the general properties of Dow Corning mold release agents for rubber and plastic is presented in the bulletin as well as major applications in the field of lubricating tire molds, curing bags, and in the lubrication of mechanical rubber goods, floor tile, and plastics. Available from the Dow-Corning Corporation, Midland, Mich.

Electronic Proportioning Pyrometer Controller. A bulletin describing a proportional current-input electronic pyrometer controller has been published by The Bristol Company, Waterbury 91, Conn. The bulletin describes the application of the new instrument in proportioning the current input to electrically-heated furnaces, ovens, plastic molding machines, salt pots, and other similar equipment to provide practically straight line control. The bulletin, number *PB1237*, can be obtained from The Bristol Company, Waterbury 91, Conn.

Socket Screw Information. A folder containing information on the application of Multiple-Spline and Hex Socket Set and Cap Screws is available from the Bristol Company, Mill Supply Division, Waterbury 91, Conn. Number *DM860.*

Low Molecular Weight Polyethylene Resins. The booklet describes the properties, methods of handling, and uses of a low molecular weight resin designated as resin *DYLT*. This polymer is being offered to the wire and cable industry as a wax additive that achieves many desirable properties, as a hot melt sealing compound and as a conductor coating. A summary of compatibility possibilities is given. Bakelite Corporation, Advertising Department, 300 Madison Avenue, New York 17, N. Y.

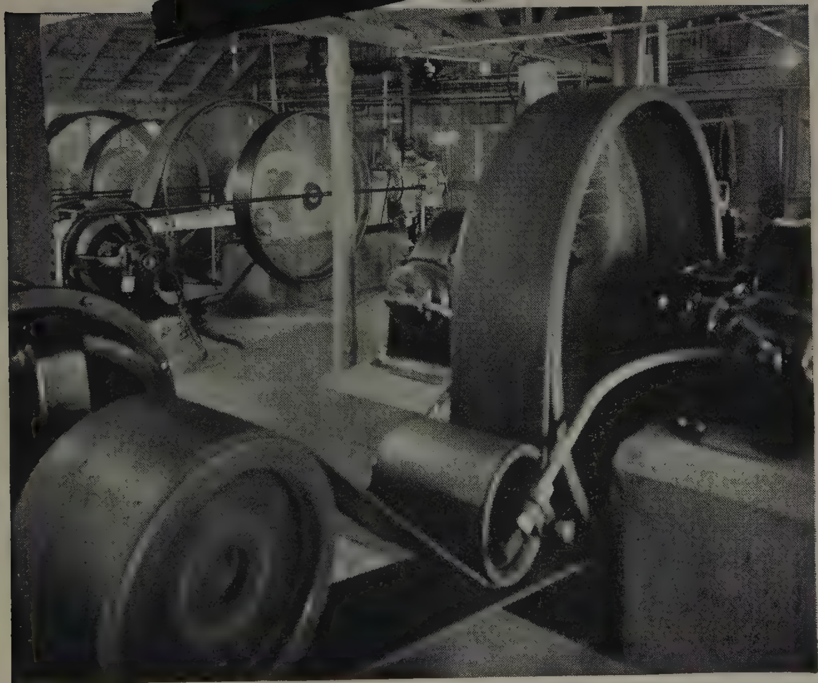
Biddle Instrument News. Low resistance and insulation resistance testing are featured subjects of the August issue of *Biddle Instrument News.* To receive a copy of this pamphlet write to James C. Biddle Company, 1316 Arch Street, Philadelphia, 7, Pa.

Power Tools Bulletin. Catalog number 486, illustrating and describing the entire line of Syntron power tools, has just been issued by Syntron Company, Homer City, Pa. This booklet includes description and illustrations of portable electric hammers, 100 per cent self-contained gasoline hammer paving breakers, external concrete form vibrators, internal flexible shaft concrete vibrators, and a complete range of sizes of portable electric drills, grinders, sanders, and their accessories.

Sound Products Catalogue. The RCA engineering products department of the Radio Corporation of America has released an 84-page illustrated "Sound Products Catalogue," listing the company's complete line of sound equipment. The booklet is divided into sections dealing with such sound products as microphones, amplifiers, speakers, program control and distribution facilities and specialty products. For copies of this new catalogue write to Sound

(*Continued on page 50A*)

CUT TOMORROW'S SHUTDOWNS, TODAY



Whenever wiring jobs come up, think beyond today's wiring needs—think in terms of cutting costly shutdowns—think in terms of maintenance-saving, time-saving Deltabeston* wires and cables. Make it a habit, wherever heat's a threat, to specify Deltabeston throughout, because Deltabeston wires and cables are made specifically to combat the effects of heat, moisture, and corrosive vapors; they give electrical systems protection from immediate hazards, and an extra margin of protection to cover future, unanticipated needs.

So whether you're rewiring an existing system or installing a system in new construction, don't overlook heat-beating Deltabeston. The Deltabeston line includes standards and "specials" for every combination of heat, moisture, corrosive vapor, or other conditions—for temperatures up to 200 C. It gives the system extra protection both on hot jobs and on ordinary installations. And, men who know your problems stand back of your Deltabeston supply source ready to advise you on selection.

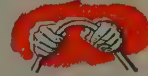
For full information on Deltabeston, write to Section Y26-1020, Construction Materials Department, General Electric Company, Bridgeport 2, Connecticut.

*TRADE-MARK REG. U. S. PAT. OFF.

GENERAL ELECTRIC

HI-AMBIENTS

Application hints on the complete Deltabeston line



FLEXIBLE HINGE CABLE for swinging panel connections and general switchboard work is available in the Deltabeston Switchboard Wire and Bus Cable line. Insulated with felted asbestos and covered with cotton braid with flame-resistant finish, it is essential for wiring switchboards up to 90 C (194 F).

SPREADING OUT. Originally designed for infrared oven use, silicone-treated Deltabeston cables proved so successful that now they're being used for both 300- and 600-volt service on many extra-high heat applications. On jobs where the temperature goes as high as 200 C (392 F), specify silicone-treated Deltabeston.

MOISTURE RESISTANCE is only one of many advantages Deltabeston power cable offers you. Like all Deltabeston products, it's a heat beater because it's insulated with purified asbestos. Varnished cambric and heavy braid or lead sheath help resist abrasion, flame, grease, corrosive vapors, and oil.

SIMPLIFIES SELECTION. To help in the selection of the proper Deltabeston magnet wires for the jobs you've got to do, General Electric has prepared the *Deltabeston Magnet Wire Booklet.* This handy guide contains facts on the many kinds of magnet wire made by General Electric, and includes a handy specification chart to make selection easy. For your free copy, write to Section Y26-1020, Construction Materials Department, General Electric Company, Bridgeport 2, Connecticut.

DELTABESTON
Wires and Cables
Built to beat the heat

TRADE LITERATURE *(Continued from page 16A)*

Products Section, Engineering Products Department, Radio Corporation of America, Camden, N. J., specifying "Sound Products Catalogue number 218-P."

NEW PRODUCTS • •

Voltage Stabilizer. A voltage stabilizer line that includes a model, custom-engineered specifically for building into electronic equipment where space and weight limitations are critical, has been introduced by Raytheon Manufacturing Company, Waltham, Mass. This miniature 5-watt stabilizer is for operation at an input voltage of 95 to 130 volts a-c, 60 cycles, single phase, with an output of 120 volts stabilized to plus or minus 1/2 per cent. Bulletin describing this line may be obtained from the company.

Mercury Relay. This relay, carrying current loads up to 35 amperes, incorporates a newly designed free-floating magnetic plunger that insures a smooth, silent operation. Because of this new feature, Ebert Engineering and Manufacturing Company, 185-09 Jamaica Avenue, Hollis, N. Y., has been able to reduce the size of the heavy glass enclosure and insure flicker-proof performance in sign-flashing applica-

(Continued on page 56A)

tions. Heavy tungsten contacts with mercury-to-mercury make and break are hermetically sealed for dustproof and moistureproof operation. There is no exposed arc and the relay is safe under all operating conditions. Coil and load terminals are readily accessible on all installations. This small relay, 4 inches by $2^{5}/_{8}$ inches by $2^{1}/_{4}$ inches available in 2- and 3-pole units, operates on 1/2-wave unfiltered current.

Roto-Ranger. The "roto-ranger" Simpson model 221, is designed as a high sensitivity a-c d-c volt-ohm-milliammeter, is equipped with rotating dials and is for use in television, radio, and industrial testing. The roto-ranger, patented by Simpson Electric Company, 5200-18 West Kinzie Street, Chicago 44, Ill., operates very simply. As the selector switch is moved to the range desired the proper scale for that range is brought into place behind the meter window. There are no cramped calibrations; each scale is large and full-sized as it would be on a separate instrument. So highly sensitive is the roto-ranger that it will measure automatic frequency control diode balancing circuits, grid currents of oscillator tubes and power tubes, bias of power detectors, automatic volume control diode currents, rectified radio-frequency current, high-mu triode plate voltage and others. D-c sensitivity is 20,000 ohms per volt. The case of this model is of wood construction, leatherette covered, and the panel of gleaming black anodized aluminum.

Control Relay. A small-size control relay that can be used on direct current and alternating current, as well as half-way rectified alternating current, has been developed by Struthers-Dunn, Inc., 150 North Thirteenth Street, Philadelphia 7, Pa. This relay, a new miniature unit identified as type *118XBX*, has double-pole double-throw contacts rated 2 amperes at 115 volts alternating current. The normal d-c operating power is 0.15 watt with a maximum coil resistance of 2,200 ohms. A-c relays operate on approximately 9 volt-amperes with coils up to 115 volts, 60 cycles. The open-type relay is $1^{1}/_{2}$ inches high by $1^{1}/_{8}$ inches long by 1 inch wide and weighs approximately 2 ounces. It can be readily enclosed in a metal enclosure $1^{3}/_{8}$ inches square and $1^{3}/_{4}$ inches high, and equipped with a vacuum tube type of octal base. The relay is also adaptable to hermetic sealing. A unique magnetic structure utilizes two working air-gaps resulting in high sensitivity on direct current. Hinge-pin armature suspension insures reliable operation under severe conditions.

Stainless Steel Drafting Machine. A machine that saves up to 50 per cent drafting labor time and cost and that will operate with perfect accuracy on any size or make drawing board without the addition of extra equipment or alteration of the drawing board has been announced by Emmert Manufacturing Company, Waynesboro, Pa. Indexing of angles is simple,

(Continued on page 64A)

NEW PRODUCTS (*Continued from page 56A*)

fast, and easy through the use of the micromatic quadrant, which allows indexing of every three degrees by simply flipping the quadrant minute-adjusting screw into desired degree setting and justments as fine as $2^1/_2$ minutes by a slight turn of the minute adjusting screw. These machines are manufactured for boards ranging from 24 inches up to 132 inches by any length, and special machines, including left-handed machines, can be furnished for odd size drawing boards. Vertical counterbalanced full size drafting board units for full size work up to 11 feet high by any length as well as draftsman's desk units, and horizontal-vertical counterbalanced adjustable board units are also available.

Selenium Rectifier. Type-*H* selenium rectifier, a product of the International Rectifier Corporation, 6809 South Victoria Avenue, Los Angeles 43, Calif., has measurements of the individual selenium elements of $6^1/_4$ by $7^1/_4$ inches rated at 12 amperes (single-phase bridge). Incorporated in these assemblies are interlocking assemblies of rectifiers components, conservatively rated terminals, and special moisture-proofing. The new elements have stable characteristics. Leakage current is less than 1 milliampere per square centimeter at 25 volts rms in the reverse direction. These assemblies are suitable for all applications requiring output in excess of 10 amperes.